DOCUMENT RESUME

ED 059 582 EM 009 498

AUTHOR	Austin, John H., Ed.; Kesler, John, Ed.
TITLE	Educational Systems for Operators of Water Pollution Control Facilities.
INSTITUTION	Clemson Univ., S.C.
SPONS AGENCY	Department of the Interior, Washington, D. C. Federal Water Pollution Control Administration.
PUB DATE	69
NOTE	412p.; Proceedings of the Educational Systems for Operators of Water Pollution Control Facilities Conference (Atlanta, Georgia, November 3-5, 1969)
EDRS PRICE	MF-$0.65 HC-$16.45
DESCRIPTORS	Computer Assisted Instruction; *Conference Reports; *Educational Technology; *Environmental Technicians; Industrial Personnel; *Job Training; Programed Instruction; Sanitation Improvement; Systems Approach; Task Analysis; Video Tape Recordings; *Water Pollution Control

ABSTRACT

Several of the articles from this conference concern current activities of federal, state, and municipal governments, of universities and community colleges, and of industry in wastewater treatment plant operator training. The rest of the articles deal with instructional technology, explaining different facets of it and showing how it may be applied to the problem. These articles deal with such subjects as: function of media and instruction, a systematic approach to instruction, task analysis requirements for upgrading occupational instruction, successful instructor training in industry, audiovisual systems from a programing viewpoint, programed manuals, educational technology, case history of video tape production, and computer based education. There are two summaries and evaluations, one from the point of view of an engineer and the other from that of an educational technologist. (JK)

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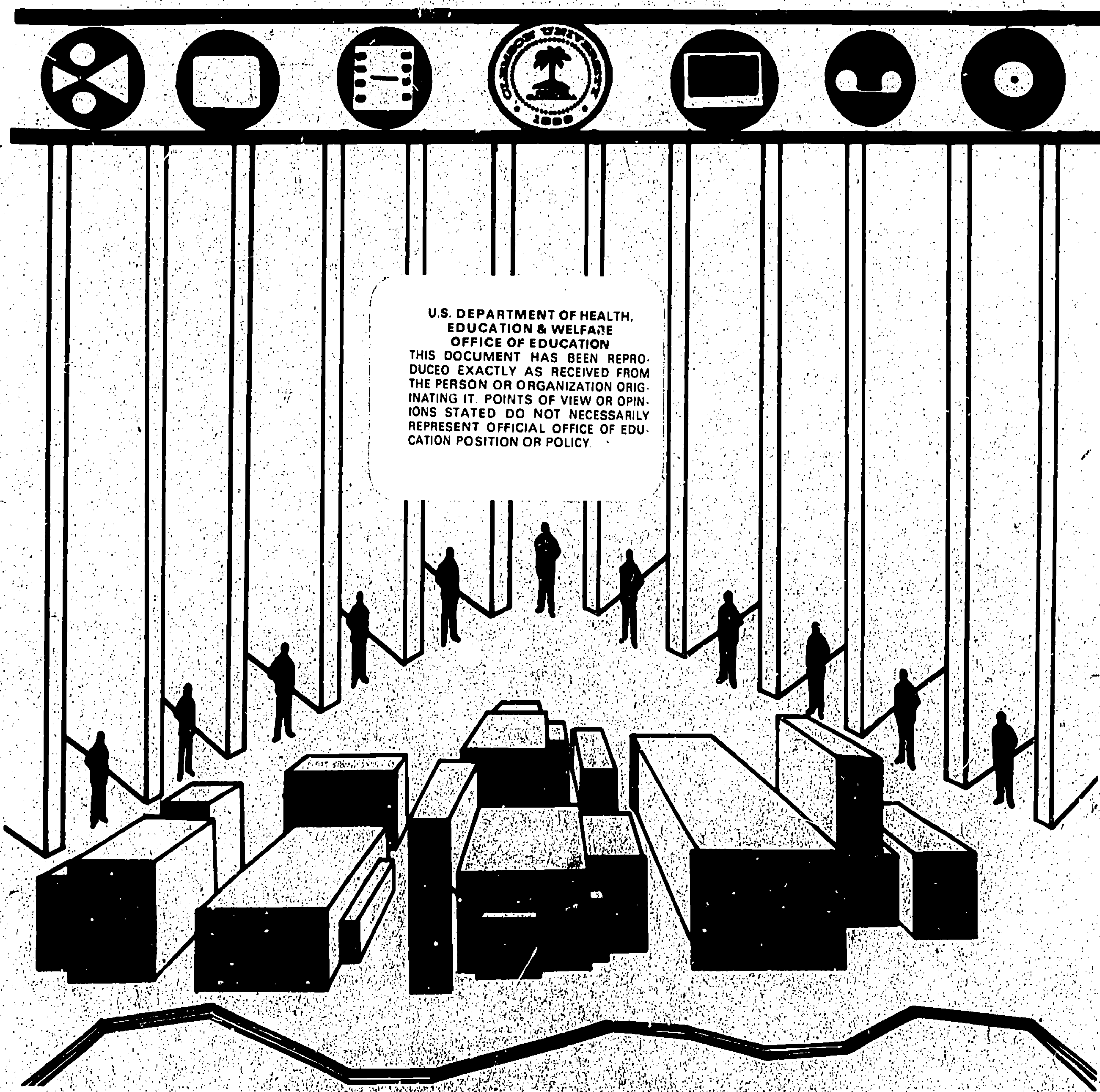

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EDUCATIONAL SYSTEMS for Operators of Water Pollution Control Facilities

Clemson University
Dept. of the Interior

CONFERENCE PROCEEDINGS

NOV. 3-5, 1969
ATLANTA, GEORGIA

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Proceedings

EDUCATIONAL SYSTEMS FOR OPERATORS OF WATER POLLUTION CONTROL FACILITIES

November 3-5, 1969

American Hotel
Atlanta, Georgia

U.S. DEPARTMENT OF THE INTERIOR

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

In Cooperation with

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Clemson South Carolina

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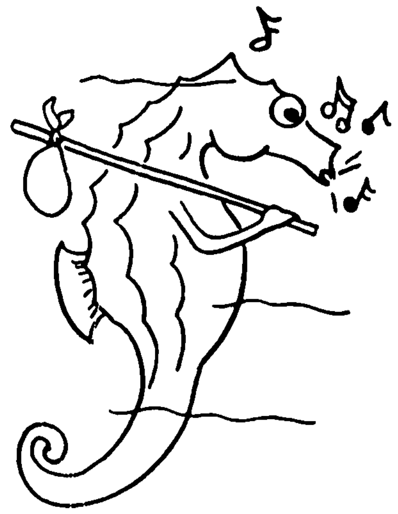
A MORAL



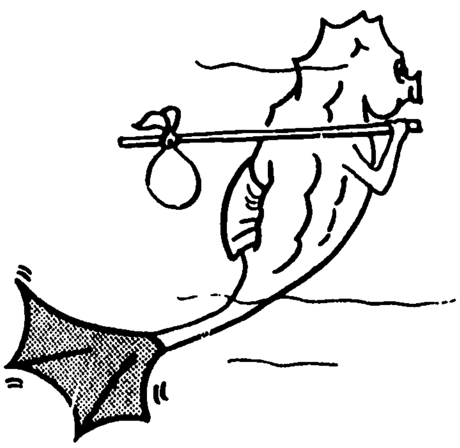
Once upon a time a Sea Horse gathered up his seven pieces of eight and cantered out to find his fortune. Before he had traveled very far he met an Eel, who said,

"Psst. Hey, bud. Where 'ya goin'?"

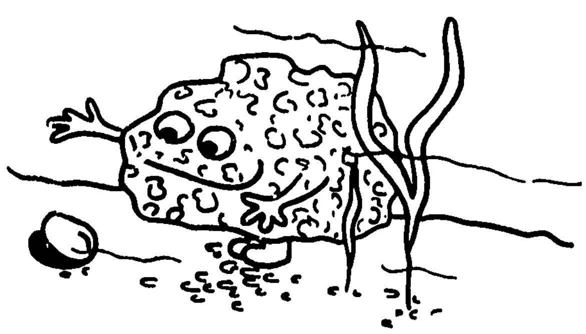
"I'm going out to find my fortune," Replied the Sea Horse, proudly.

"You're in luck," said the Eel. "For four pieces of eight you can have this speedy flipper, and then you'll be able to get there a lot faster."

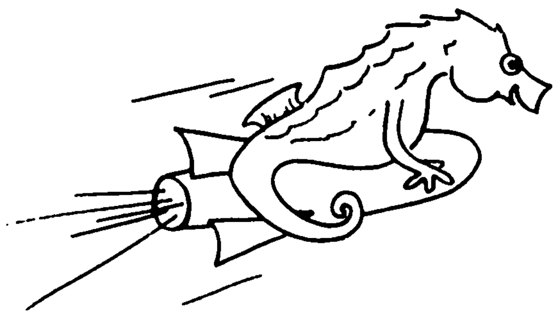
"Gee, that's swell," said the Sea Horse, and paid the money and put on the flipper and slithered off at twice the speed.



Soon he came upon a Sponge, who said, "Psst. Hey, bud. Where 'ya goin'?"



"I'm going out to find my fortune," replied the Sea Horse. "You're in luck," said the Sponge. "For a small fee I will



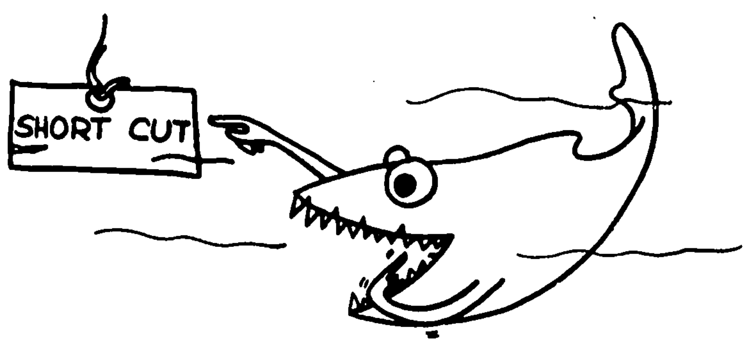
let you have this jet-propelled scooter so that you will be able to travel a lot faster."

So the Sea Horse bought the scooter with his remaining money and went zooming thru the sea five times as fast.

Soon he came upon a Shark, who said, "Psst. Hey, bud. Where 'ya goin'?"

"I'm going out to find my fortune," replied the Sea Horse.

"You're in luck. If you'll take this short cut," said the Shark, pointing to his open mouth, "you'll save yourself a lot of time."



"Gee, thanks," said the Sea Horse, and zoomed off into the interior of the Shark, there to be devoured.

The moral of this fable is that if you're not sure where you're going, you're liable to end up someplace else.

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Robert F. Mager, Ph.D.
PREPARING INSTRUCTIONAL OBJECTIVES

TABLE OF CONTENTS

Page

Page

ERIC

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It is a pleasure for me to address this conference. I feel that the waste treatment plant operator is a key figure in the fight for clean water. I am glad to see him receive this kind of attention. I understand that this conference deals with many of the specifics of operator training, but I want to take a few minutes to discuss with you some of the broader policy considerations that I think are important.

One of the significant characteristics of the Nixon Administration is, and will continue to be, an emphasis on the enforcement of the water quality standards. Since these standards establish goals for upgrading and maintaining the quality of receiving streams, there will be a great deal of pressure on State and local governments and private industry to improve the quality of effluent from waste treatment plants. This means better operation and maintenance of plants. In other words, the operator must do a better job.

While we are going to be putting pressure on with one hand, we are going to be trying to help with the other hand.

It is in this context that I want to discuss with you what must be done.

There are three important things we can do to improve the performance of operators:

1. We can recruit higher quality trainees;

2. We can provide adequate training, both in terms of initial instruction and subsequent skill, upgrading and maintenance; and

3. We can retain our better operators by improving job conditions.

This last item brings me to a critical point -- much time spent on training operators is wasted where a plant or a system has a high turnover rate. Where a high turnover rate exists there is a constant stream of new recruits who require orientation and initial instruction. When a large amount of training resources must be devoted to this function, less remains for the effort to upgrade or update the skills of the remaining employees. This latter effort, where you deal with persons who have some interest and job experience upon which to build, can be extremely productive in terms of improving plant performance.

I suspect that few people would argue with the proposition that limited training programs could be more productive if they could be concentrated on skill enhancement of experienced employees instead of being spent on introductory-level courses. The question, of course, centers on how to avoid high turnover rates.

What must be done to retain experienced operators? Simply put, job conditions must be improved:

--Wages must be increased to the point where competent, experienced operators do not forego better pay by continuing work at the treatment plant;

--Jobs should be structured so that the operator will have before him, and be aware of, a clearly defined career ladder that will serve as a goal, that will provide him with an incentive to improve his capabilities;

--The image of the operator must be improved. The public must be made aware of the importance of his contribution. Only when this has occurred will an appropriate level of public recognition and respect be accorded operators. And all this must happen before we can reasonably expect that operators will be proud of their jobs.

Many other items could be listed, but I feel they all deal with making the operator occupation one in which the operator can be satisfied -- one in which he can develop and expand his self-respect over a period of years. This will occur only when operators feel they are adequately paid, where there is tangible incentive for improving one's skills, and where an operator is proud of his job -- proud of working at a waste treatment plant.

I am not making a plea for municipalities and industries to spend a lot of money simply to make operators happy. Rather, what I am speaking about is sound business practice.

Spending money to achieve improvements in operator recruitment, training and retention can result in large-scale savings. In terms of plant investment, by improving plant performance we can avoid the unnecessary replacement of existing plants which are not meeting water quality standards but are basically capable of doing so. In some cases these plants may never have been operated at their full capacity levels. By improving plant maintenance we can greatly enhance the useful life of a plant, thereby reducing the capital requirements for plant replacement.

Let me return to an earlier topic that also has a significant impact on operation and maintenance costs -- turnover. Turnover is extremely costly. A great deal of money and supervisory and administrative time is spent in recruiting, orienting and providing basic instruction to new operators. This cost can be reduced by lowering the turnover rate. Further, if we assume that experienced operators will outperform less experienced operators, we can see another impact of a high turnover rate. Average experience of the individual operator is ten years if the turnover rate is 10 percent, but is only 3-1/3 years if the rate is 30 percent.

The decision on whether to commit funds to improve operator recruitment, training and retention should take into account all costs -- not just the costs associated with recruitment, training and retention. The costs of not improving recruitment, training and retention must also be

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considered. These costs include unnecessary investments in new facilities and the costs of a high turnover rate. And there are perhaps even more important costs -- closed swimming beaches, fish kills, and a general assault on the senses, which result from the detrimental impact on water quality of a poor plant operation.

Nationwide polls reflect the public's concern with water pollution. For example, a poll published last month by Newsweek Magazine shows that 56 percent of those queried believed that the government should spend more money on air and water pollution. This was a top percentage figure. And only 3 percent said the government should spend less money on air and water pollution.

Earlier in the year, a Gallup poll showed that 51 percent of all persons interviewed were "deeply concerned" about environmental pollution. The poll showed that nearly three-fourths of those interviewed were willing to pay something in additional taxes to improve our natural surroundings.

Certainly the results of these and other polls show that the American people are keenly aware of the benefits provided by clean water and are willing to pay for these benefits.

I have been speaking only about water pollution control, but we at FWPCA realize that water pollution control is but one important aspect of a broader concern that will be receiving increasing emphasis over the next several years.

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This is concern both at policy levels and at the grassroots about the quality of life in America. I think this is one of the reasons for the discontentment of the young people -- they realize that some basic things, like water and air, could be much better than they are. A manifestation of FWPCA's concern with the broader aspects of environmental quality control is the cooperative approach being taken to the development of a manpower planning system. FWPCA staff is working with the Department of Health, Education, and Welfare's Consumer Protection and Environmental Health Service (CPEHS) on the development of a manpower planning system that would span the environmental fields -- including such areas as water pollution, air pollution, solid waste, water supply and noise. The primary reason for making this type of consolidation is that these fields often compete with each other for the same occupational and educational groups -- for example, sanitary engineers are sought by most of these programs.

We are looking towards the increased funding authorization for manpower planning contained in S. 7, a bill pending before the Congress, to finance FWPCA's costs of developing and participating in such a system. Dr. Hirsch, FWPCA's Assistant Commissioner for Operations, will go into greater detail on this extremely important manpower planning program in his presentation (see pages 81 to 92).

Under consideration by the Congress is H. R. 4148 a bill dealing with water pollution control which contains training provisions aimed at improving plant operation and maintenance. Congressman William C. Cramer, tonight's banquet speaker, developed these provisions.

The provisions of both the Senate and House bills will be of great assistance to us in our training program. I hope that the Congress will act favorably and soon on them.

In addition to our concern for coordinating with other Federal agencies, State and local government agencies, private industry and the academic community -- we realize that much can be accomplished within FWPCA by devoting increased attention to the manpower aspects of many of our activities. We are already pursuing this course of action. In connection with our waste treatment construction grants program, we are devoting increased attention to operation and maintenance of plants. Projections of future plant construction form a base for estimating one aspect of the demand for new operators.

We have established a regular procedure at FWPCA to gather information on manpower requirements or utilization in conjunction with work performed for us under grants and contracts.

Planning activities can also serve as indicators of likely future demand for personnel of all types.

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Implementation schedules of the water quality standards program provide us with specific data on new plant construction.

In short, we know that data about manpower demand and utilization can be generated by applying information developed through many FWPCA programs -- and we plan to see that it is.

Now let me return to the three steps to improving operator performance that I mentioned before, and indicate where I think FWPCA can be of assistance.

First, we need to recruit higher quality trainees. This involves improving wages and other job conditions, enhancing the image of the operator occupation, and doing a better promotion and recruitment job. FWPCA intends to contribute towards this effort by preparing one or more films dealing with the importance of the operator, and indicating the opportunities that can be available to operators in progressive systems. These films will be made available to governmental agencies, public interest groups, professional groups and other organizations interested in studying or publicizing the need for improved operator performance. We will also furnish advice and consultation on improving job conditions and recruitment efforts to State and local governments as requested, since this is an especially severe problem for them.

Interested agencies should make the initial contact with a FWPCA regional office. These are located in Boston, Massachusetts; Charlottesville, Virginia; here in Atlanta; Cincinnati, Ohio; Chicago, Illinois; Kansas City, Missouri; Dallas, Texas; Portland, Oregon; and San Francisco, California. Each region has a Manpower Development and Training Officer who is responsible for FWPCA manpower improvement programs in that region.

Second, we need to provide adequate training for new and existing operators. Dr. Hirsch plans to go into some detail on current and proposed FWPCA activities in this area. I do want to mention a spin-off from our manpower planning activity. One aspect of determining the potential supply of trained manpower is to survey existing training opportunities. We plan to make this information available to everyone responsible for training through the creation of a Training Information Exchange. At this point the location and details of operation of this activity have not been established. However, the objective of the Training Information Exchange is organized, comprehensive information. When this service is operational, a municipal or industrial official responsible for operator training will be able to have before him a listing of all training opportunities that might meet his needs, including information on training dates, duration of courses, cost, location, and a brief description of the course's contents.

Third, we need to retain our experienced operators. Many of the factors I mentioned under the first item, the recruitment of higher quality trainees, applies here as well. FWPCA plans to concentrate on enhancing the operator's image so as to make the occupation more attractive. I mentioned that we plan to prepare films and stand ready to serve as consultants. We look forward to working especially closely with State and local governments to help them reduce turnover rates -- since they have more serious problems in this area than do industrial plants.

The responsibilities for efforts to improve the operators' contribution to water pollution control rest heavily upon State and local governments, particularly with regard to wage levels. State and local governments require and deserve assistance in carrying out these responsibilities and such assistance is available from FWPCA, educational institutions, and a variety of public and private organizations.

For example:

--Junior colleges and community colleges are actively seeking roles in operator training. FWPCA has assisted several institutions to qualify for funding by other Federal agencies.

--We are exploring the possibility of encouraging secondary schools to introduce an emphasis on pollution control in high school science courses. We hope to award a developmental grant in this area this Fall.

--The League of Women Voters is conducting a public information program keyed to future water needs. This consists of a series of regional meetings and study sessions with community leaders.

--The American Public Works Association has proposed a study of the manpower requirements of local sewage collection systems. This proposal is currently under study within FWPCA.

--And finally, this important conference, which was arranged by Clemson University.

At this point, I wish to express my personal thanks to Clemson University for conceiving and organizing this splendid conference. This is the first meeting of its kind and I think that this is really a historic milestone in our effort to focus proper attention on manpower and training needs in the field of environmental quality control.

This conference will be a contributor to the growing crusade within America to enhance and preserve environmental quality.

Effective and efficient operation of treatment plants is of paramount importance in our drive for clean water.

So it boils down to this. Treatment plant operators are an essential, a vital, factor in the national clean water program. Without good plant operators in sufficient numbers we'll never make it.

The task of upgrading and improving the operator occupation and thereby increase the operators' contribution will be accomplished if we choose to mount a coordinated, cooperative approach which utilizes the brain power, facilities and funds of a wide variety of public and private organizations. For my part, I plan to see that FWPCA plays a full and active part in this most critical effort.

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TRAINING PROBLEMS AND NEEDS OF THE LOCAL LEVEL
ORANGE COUNTY, CALIFORNIA

Fred A. Harper
County Sanitation Districts
of
Orange County, California

INTRODUCTION

During the past several years state and local agencies have invested billions of dollars to upgrade existing wastewater treatment facilities and to construct completely new plants where none existed. Since 1956, the federal government alone has invested over a billion dollars to improve the nation's water quality. Today, tremendous financial assistance programs for the construction of additional future facilities are being considered at all levels of government. However, this in itself will not solve our nation's water pollution problems.

Our industry must have properly trained, skilled personnel to operate the facilities which are becoming more complex every day. Many times treatment works have been designed and constructed with little or no thought given to who would operate them after completion. More often than we like to admit, a treatment facility is staffed by personnel who were not able to perform their duties in other capacities within the city framework.

NEED FOR AWARENESS

The governing bodies, such as the city councils, have not been made aware of the personnel needs of this vital community service. Perhaps the city council, if you will, assumes that it is spending it's funds for an automated plant which will solve the city's pollution problems; however, someone fails to make the council aware that machines and electronic gear must be properly maintained and operated if the wastewater treatment plant is to perform the function for which it was designed. Many cases can be cited where engineers have been criticized for designing inefficient facilities, when actually the problems were due to improper maintenance and operations.

It is our responsibility to make our governing bodies aware that they must have skilled and trained personnel to operate their facilities efficiently. First, they must be prepared to offer salaries commensurate with the skills required, and second, they must be willing to provide adequate training.

APPRENTICE PROGRAM

For several years the Boards of Directors of the agency I represent have been aware of the need for trained personnel. In 1966, at a time when we were experiencing problems in hiring qualified people to take positions in the operations and maintenance departments, our Directors authorized the development of an Apprentice Program specifically designed to interest the mechanically inclined high school graduate. The program's objective is to train personnel for the maximum benefit to the Districts, the individual, the community, and industry. It was recognized from the beginning that the Districts would lose a percentage of the men trained; however, the Directors believed the improvement of the individuals could only result in an improved community. This program was instituted in 1967; the results have been gratifying to our Directors and the program has been meaningful for our young people. Because of this, the apprentice concept has been extended to a four-year curriculum, permitting those who complete the initial two years to continue to specialize in one phase of our industry. Of course, we recognize that training of this type is not possible everywhere, mainly because many entities have a very small staff, but I presented this example to illustrate what can be done when a governing body is made aware of the needs of the entity.

INDIVIDUAL OPERATOR NEEDS

In reference to the community where the wastewater treatment plant is operated by a small staff, the training needs are considerably different than those of a large metropolitan sewerage system which is very departmentalized.

The local treatment plant operator needs a place or person to call for advice. He must know where he can exchange information with others engaged in the same type of operation. He needs periodic visits from staff personnel of the regulatory agencies to discuss his problems and how he can better operate the facilities. He needs a place where he can send his personnel for short-term courses directed at maintenance and operations problems. He needs a source from which he can select new employees who will have a basic understanding of the wastewater treatment process.

To accomplish this, each entity -- the local, State and Federal sectors -- must include in their costs of operations, funds to properly train the personnel who have the responsibility to operate efficiently the facilities in which the public has invested so much in the effort to solve the water pollution problems our nation is facing today.

DISTRICT CHARACTERISTICS

The Orange County Sanitation Districts' wastewater quality control system in metropolitan Orange County, California, the third largest on the West Coast, serves a current population of 1,250,000 with facilities valued at more than $100,000,000. This area, for which forecasters anticipate a population of 2,500,000 by the year 2000, had only 200,000 inhabitants in 1950. By necessity the Districts are continually planning and constructing facilities to

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provide the required wastewater disposal services as the population and development increase.

At the present time there are seven Sanitation Districts owning and maintaining about 400 miles of major trunk sewers with more than 20 pump stations. Jointly the Districts operate two treatment plants to process wastewater to the Pacific Ocean.

Plant No. 1, located about four miles from the coast adjacent to the Santa Ana River bed, has an operational hydraulic capacity of 75 million gallons. This plant gives primary treatment to all of its flow and secondary treatment to 15 million gallons per day. The secondary treated water is made available to a tertiary treatment plant for the Orange County Water District salt water intrusion barrier project.

Plant No. 2 is located 1500 feet from the ocean at the mouth of the Santa Ana River and can handle a hydraulic load of 170 million gallons per day. The flow averages about 80 million gallons per day in that plant and is given primary treatment.

Serving both plants is one of the world's largest chlorination stations for disinfection of the effluent, and outfall booster facilities used to pump the flow through a 78" outfall extending 8000 feet to sea. At the present time a new ocean outfall is under construction which will extend five miles to sea, having a hydraulic capacity of 480 million gallons per day. The Districts spend approximately 4 million dollars a year improving and expanding the treatment facilities.

A single professional staff administers the work of all districts and operates the joint treatment facilities. This staff consists of a total authorized personnel complement of 146. Nineteen are in administrative, finance and clerical positions and 127 are employees in the engineering, maintenance and operation departments.

In November, 1966, the Joint Boards of Directors, recognizing the need for a program designed to train and develop qualified personnel to operate and maintain wastewater treatment and disposal facilities, authorized the Districts' staff to proceed with the development of an apprenticeship program. During the ensuing six months a great deal of time and effort was put forth in developing a rather comprehensive training program.

Initially, the program was envisioned as a two-year general training period covering all activities of a wastewater treatment agency. However, it became apparent that upon completion of the proposed two-year training period, the apprentice would have become familiar with the over-all operations but would not have spent sufficient time in any given area to develop a journeyman skill. The program concept was then expanded into two phases. The Apprentice I phase, which is a two-year period of training covering all areas of operations and maintenance, is aimed toward the recent high school graduate with a mechanical aptitude who does not wish to continue his formal education; and the Apprentice II phase, which is an additional two-year period of training in a specific area, is for the Apprentice I graduate who desires to continue in the program.

The full Apprentice I program began July 1, 1967, and the Apprentice II program was initiated at that time on a limited basis in two technical departments.

The Districts have been very pleased with the results of the program and have realized many side benefits from its implementation. We have found that in addition to developing qualified new personnel, existing personnel involved in the actual training of the apprentices also benefit from the preparation required of them as instructors, as well as the experience gained from application of training methods and techniques.

From time to time as experience has dictated, we have modified the original Apprentice I program. In July, 1969, the full Apprentice II program was initiated in those departments in which it was felt that a detailed two-year training program would be beneficial in developing skilled personnel.

The Districts currently have eight Apprentices I in training, and six Apprentice II positions in the Table of Organization.

Outlines of the general provisions for both apprentice programs of the Orange County Sanitation Districts follow. These apprentice programs were designed for the specific needs of our Districts. We believe it is one of the major reasons why the program has been successful to date.

APPENDIX A

APPRENTICE I PROGRAM

Objective:

To train personnel for the maximum benefit to the Districts, the individual, the community and industry.

It is recognized, as in any apprentice program, that the Districts will lose a percentage of the men trained. However, it is believed the improvement of individuals can only result in an improved community.

The Apprentice I program is generally directed toward the progressive development of recent high school graduates by on-the-job training.

Requirements:

1. High school diploma (consideration may be given to qualified applicants with GED certificates.)
2. Recommendation by high school administration.
3. Age limitation - twenty-five (25) years or younger on entering the program.

4. Commitment by applicant as to his intention to complete the program outlined by Management.

5. In initiating the program, consideration may be given to present employees who express an interest in the program and meet the requirements. If the employee requests a transfer to the program, the salary will be established at his present rate or the top step of the apprentice-range, whichever is lower.

6. Approval by the General Manager, of all entrants in the program.

Program Outline:

I. General Plan

A. An Apprentice I program shall consist of three (3) months training in each of the following categories:

1. Maintenance of Sewage Transmission Facilities
2. Electrical and Instrumentation Systems
3. Mechanical-Stationary Equipment
4. Mechanical-Mobile Equipment
5. Plant Maintenance
6. Laboratory Procedures
7. Engineering
8. Plant Operations

B. Detailed training in each category is listed on the attached plans. These plans are subject to revision by the General Manager as experience dictates. The training plans specify the required hours in each subject. The actual training supervisor is allowed some latitude in the program. The required hours in each subject are 5% to 20% fewer than the total hours required in each category. The supervisors will use these hours as best suits the needs of the Districts and the Apprentice I.

C. A monthly progress report shall be maintained by the Supervisor to assure compliance with the detailed Apprentice I program. The Apprentice I shall keep a detailed record of time worked on each subject and turn in appropriate records monthly.

D. Supervisors shall schedule training so that at least 30% of the required time is covered each month.

E. While the listings of the eight major categories are random, some restrictions exist on the sequence of training.

1. Mechanical-Stationary Equipment must precede Mechanical-Mobile Equipment.

2. Plant Operations must be preceded by at least one period in some other area of the Plant site excluding Transmission Facilities.

II. Evaluation

A. Upon completion of each category of training, a performance review will be completed by the supervisor and the review will be processed through current procedures.

B. The continued participation in the apprenticeship program shall be subject to approval of the General Manager.

III. Classification and Salary

A. A classification of Apprentice I shall be established for this position.

B. The salary range for this position shall be established as two Ranges (11%) below the salary range for the Districts' Utilityman classification.

C. The salary resolution shall provide that the Apprentice I shall be eligible for a half-step increase in pay upon satisfactory completion of each three-month's training period, upon approval of the General Manager.

D. Upon completion of the program, the apprentice shall be reclassified. In the event there are no openings in an appropriate classification, the apprentice will be reclassified at such time as the first appropriate opening occurs, and before consideration is given to an outside applicant.

E. The classification of Apprentice I is to be considered a full-time permanent position and as such, the apprentice will be entitled to the applicable employee benefits.

F. A beginning Apprentice I shall start on the first working day of the month and subsequent changes in categories shall be effective on the first working day of the month.

IV. Special Conditions

A. The Safety Committee will make a special effort to see that all Apprentices I are instructed in safety practices and procedures.

B. The Training Committee will make available such material and training as is necessary to properly instruct the Apprentice I.

C. The Apprentice I will be required to work some shift work and/or overtime and will be reimbursed in accordance with established salary provisions.

D. Instruction of the Apprentice I will be to the level of Maintenance Man or equivalent. (While time will be too short for full comprehension at this level, subsequent advanced training at a later date will be more comprehensive.)

E. No Apprentice I will be allowed to stand an operational shift alone.

APPENDIX B

APPRENTICE I - PLANT MAINTENANCE

SUBJECT	HOURS
Grounds Keeping	40
Proper care and trimming of shrubs and trees. Care of lawn and beds. Weed control.	
Barscreens	20
Servicing and repair of barscreens and conveying equipment.	
Incinerators	20
Servicing, cleaning and repair of incinerators and feed mechanisms.	
Clarifier and Sludge Pumping	60
Servicing of clarifier mechanisms. Servicing and repair of sludge pumps and metering devices.	
Digester Equipment	40 (60)
Servicing and repair of circulating and gas pumps. Maintenance of lines, valves and digester safety equipment.	
Construction	40
Carpentry, building forms, shelving, woodwork repair, masonry, brickwork, block walls, cement handling and finishing.	
Boilers	16
Servicing, cleaning and repair of boilers and associated equipment. Feed water treatment.	
Pipe Fitting	60 (80)
Principles of fitting pipe using both screwed and flanged pipe.	

ERIC

PLANT MAINTENANCE

(Continued)

SUBJECT	HOURS
Painting	40
Proper preparation of surfaces. Painting for protection from atmosphere. Selection of proper type of protective coatings.	
Warehouse	24
Familiarization with procedures for issuing and accounting of stores.	
Digester Cleaning	20 (40)
Cleaning and returning a digester to operation. Methods of grit disposal. Safety and ventilation.	
TOTAL REQUIRED	380

NOTE: Figures in parentheses show suggested places where extra time is thought to be most needed.

Last item may not be covered in period of training due to scheduling but will be included before end of course.

APPENDIX C

APPRENTICE I - COLLECTION FACILITIES

SUBJECT	HOURS
Small Lines	80
Safety procedures - traffic control - various cleaning procedures - disposal of solids.	
Large Lines	80
Safety procedures - traffic control - various cleaning procedures - disposal of solids.	
Trunk Flow Measurements	40
Safety and traffic control, dye tests, gauging procedures, installation and servicing of water height recorders.	
Station Run	80
Service, cleaning and inspection of pump stations. Participation in preventative maintenance and diagnosis.	
Stoppages	40
Methods and equipment usage to clear stoppage of large or small lines.	
Station and Line Service	80
Installation and repair of pump station equipment. Inspection of backfilling.	
TOTAL REQUIRED	400

APPENDIX D

APPRENTICE I - MECHANICAL STATIONARY EQUIPMENT

SUBJECT	HOURS
Basic Principles of Engines Textbook and cut-away model. Study of 2 and 4 cycle, gas, gasoline and diesel principles.	40
Preventative Maintenance on Engines Inspection, adjustment and servicing of stationary engines.	80
Preventative Maintenance on Governors Servicing of hydraulic, mechanical and electronic types.	20
Preventative Maintenance of Carburetors Servicing and repair of gas and gasoline carburetors.	20
Engine Controls Instruction in basic principles of automotive engine controls.	20
Major Overhaul Assist in major overhaul of large internal combustion engine.	40
Gear Boxes & Large Pumps Adjustment and servicing of bearings and gear tooth contact. Herringbone, bevel, worm and planetary servicing and repair of large pumps.	60
Compressors Service and repair of reciprocating and rotary gas and air compressors.	40

ERIC

MECHANICAL STATIONARY EQUIPMENT

(Continued)

SUBJECT	HOURS
Pressure Regulators and Power Actuated Valves	20
Theory of operation, servicing and repairs. Includes related equipment.	
Turbines - Gas and Steam	60
Theory and servicing of gas and steam turbines. Includes study of waste heat recovery unit and associated equipment.	
Heat Exchangers	20
Theory of heat exchanger, cleaning and servicing heat exchangers.	
	420

ERIC

APPENDIX E

APPRENTICE I - MECHANICAL-MOBILE EQUIPMENT

SUBJECT	HOURS
Vehicle Servicing	80
Gassing, washing, lubrication of cars and trucks.	
Minor Tune-Up	40
Maintenance and repair of ignition and carburetion system.	
Major Inspection & Servicing	40
Brake, bearing and gear box inspection and adjustment.	
Major Tune-Up	30
Inspection and servicing of electrical components, fuel system, valve train adjustment, and engine performance analysis.	
Preventive Maintenance Scheduling	20
Instruction in selection of proper interval for preventative maintenance of equipment. Completion and filing of records.	
Portable Equipment	20
Servicing, testing, and inspection of portable equipment including state of readiness of emergency equipment.	
Transmissions	24
Theory and repair of mechanical type transmissions.	
Differentials	24
Theory and repair of automotive type differentials.	

MECHANICAL-MOBILE EQUIPMENT

(Continued)

SUBJECT	HOURS
Steering and Brakes	32
Service and repair of systems including power assisted types.	
Hydraulic Systems	20
Theory, service and repair of hydraulic control systems including brakes, power shovels and backhoes, and hydraulic cranes.	
Steam Cleaning and Painting Preparation	20
Proper methods of cleaning, sanding, and masking of mechanical equipment for repainting.	
Engine Breakdown	20
Assist in repair of automotive type engines.	
Welding	40
Elementary welding and cutting using both electric and gas torches.	
TOTAL REQUIRED	410

ERIC

APPENDIX F

APPRENTICE I - ELECTRICAL MAINTENANCE

SUBJECT	HOURS
Basic Electrical Principles	60
Safety, use of tools and equipment. Soldering, splicing, and connecting wires. Proper use of meters.	
Metering	80
Basic operation of metering elements. Servicing of meters and recorders.	
Plant Service and Transformers	80
Installation, hook-up and testing of Plant electrical service.	
Utility Service	20
Safety and work on Plant transmission equipment.	
Motors	30
Service and repair of electic motors.	
Switch Gear	60
Operation and servicing of circuit breakers, transfer switches. Distribution system for each Plant.	
Control Circuits	40
Servicing and repair of control circuits for Plant equipment.	
Telemetering	30
Transmission of signals by leased lines. Conversion of metering signals for transmission. Coding and decoding tone signals.	
TOTAL REQUIRED	400

ERIC

APPENDIX G

APPRENTICE I - PLANT OPERATIONS

SUBJECT	HOURS
Treatment Plant No. 1	160
(80 hours will be on shift work) Operation of all units of the Treatment Plant to include records and sampling.	
Treatment Plant No. 2	160
(80 hours will be on shift work) Operation of all units of the Treatment Plant to include records and sampling.	
Chlorine Station	80
(40 hours will be on shift work) Operation, servicing and routine maintenance of the chlorination equipment, trickling filter plant, outfall booster station and related testing procedures.	
Sludge Handling	40
Operation of the centrifuge and sludge handling equipment to include servicing, records and sampling.	
Control Center	40
Operation with a Control Center operator. Interpreting the operating conditions of the units from the console displays. Record keeping and chart servicing.	
TOTAL REQUIRED	480

NOTE: Apprentice I will not stand an operating shift alone.

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APPENDIX H

APPRENTICE I - CONTROL LABORATORY

SUBJECT	HOURS
Introduction to Procedures	10
Laboratory safety and familiarization with basic equipment.	
Sampling	40
Proper sampling of various plant streams, liquid, solid, and gas. Handling and storage of samples and proper preparation for analysis.	
Sludge and Digestion Analysis	80
Analysis of sludges from throughout Plants. Analysis of digester contents and how each parameter affects operational efficiency.	
Sewage Analysis	120
Analysis of sewage and industrial waste samples for routine and special analysis.	
Bacteriology	120
Collection and analysis of samples for bacteria control. Study of various methods for confirmation of results.	
Chlorination Analysis	20
Analysis of chlorine residual and demands on various types of treatment plant streams and preparation of analytical reagents.	
Quantitive Analysis	40
Introduction to the procedures for analyzing samples in a quantitive manner.	
TOTAL REQUIRED	430

APPENDIX I

APPRENTICE I - ENGINEERING

SUBJECT	HOURS
General	60
Introduction to departmental procedures, equipment and methods.	
Drafting	100
Translation of physical configurations into representative drawings involves both field and board work.	
Surveying	180
Elementary surveying. Use of tools and instruments.	
Inspection	60
Inspection of contract work for compliance with plans and specifications, sampling and testing of material. Includes inspection of trunks and connections.	
TOTAL REQUIRED	400

APPENDIX J

APPRENTICE II PROGRAM

Objective:

To train personnel for the maximum benefit to the Districts, the individual, the community and industry.

It is recognized, as in any apprentice program, that the Districts will lose a percentage of the men trained. However, it is believed the improvement of individuals can only result in an improved community.

The Apprentice II program is generally directed toward the progressive development of advanced skills in specialized fields of the Districts' operations. It is specifically for graduates of the Apprentice I Program.

Requirements

1. High school diploma (consideration may be given to qualified applicants with GED certificates).
2. Age limitation - twenty-eight (28) years or younger upon entering the program.
3. Satisfactory completion of Apprentice I Program.
4. Commitment by the applicant as to his intention to complete the program as outlined by Management.
5. Approval of all entrants to the program by the General Manager.

Program Outline

I. General Plan

A. The Apprentice II program shall consist of two (2) years training in one of the following specialized fields:

ERIC

1. Electrical

2. Mechanical - Mobile and Stationary

3. Plant Operations

4. Plant Maintenance & Construction

5. Laboratory

6. Engineering

B. Emphasis will be given toward developing a safety consciousness and all Apprentice II's are required to attend all safety meetings.

C. The detailed Apprentice II program shall be in accordance with a plan developed by the staff and approved by the General Manager.

D. Outside schooling will be required to supplement on-the-job training. The amount of outside schooling required shall be equivalent to thirty college semester units. The required subjects shall be established by the various departments. The Apprentice II will be expected to accomplish this on his own time and at his own expense.

E. A progress report will be maintained by the supervisor to assure compliance with the detailed Apprentice II program. The apprentice will keep required records and reports will be reviewed quarterly by a committee designated by the General Manager.

F. A certificate will be issued to recognize satisfactory completion of the program.

II. Evaluation

A. The Apprentice II shall have his performance reviewed not less than quarterly by his immediate supervisor. The review shall be processed by current personnel review procedures.

B. Continued participation in the Apprentice II program shall be subject to approval of the General Manager.

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III. Classification and Salary

A. The classification of Apprentice II shall be established in the participating departments.

B. The salary range of this position is established independently in each department to conform with its current salary structure.

C. Provisions shall be made to enable the Apprentice II to be eligible to receive a one-half step salary advance upon the satisfactory completion of each six-month period of training, upon approval of the General Manager.

D. Upon completion of the program, the Apprentice II shall have been trained to the skilled level established by each department. If there are no openings in an appropriate classification at that time, the Apprentice II will remain in his position and will be assigned first priority for the first appropriate opening that occurs.

E. Upon promotion, personnel reviews and eligibility for salary advances shall be in accordance with current regulations for positions not designated as Apprentice (i.e., annually). This provision shall also apply for the remainder of the Apprentice II salary range in the event he completes the program but is awaiting a promotional opening.

F. The classification of Apprentice II is considered a full-time permanent position and as such the apprentice will be entitled to the appropriate employee benefits.

G. A beginning Apprentice II shall start on the first working day of a calendar quarter.

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APPENDIX K

APPRENTICE II - PLANT MAINTENANCE DEPARTMENT

EQUIVALENT DEPARTMENTAL POSITIONS: Maintenance Man; Heavy Equipment Operator I; Groundskeeper II

PROMOTIONAL POSITION UPON COMPLETION OF PROGRAM: Maintenance Mechanic I

EDUCATIONAL REQUIREMENTS: Satisfactory completion of the equivalent of thirty college semester units in courses approved by the Department Head. A minimum of fifteen units must be in trade associated courses.

DEPARTMENTAL TRAINING PROGRAM DETAIL: The Apprentice II shall receive training to the extent that he can demonstrate he has achieved the level of proficiency required in each of the following categories:

I. ROUTINE PREVENTATIVE MAINTENANCE

A. Plant Equipment

B. Scheduling

C. Performance

D. Record Keeping

II. CONSTRUCTION - (Lay Out and Detailing of Work)

A. Carpentry

B. Painting

C. Masonry

D. Rigging

III. PIPE FITTING

A. Proper Procedure

B. Installation

C. Pipe Fitting Identification (duPont Courses)

ERIC

IV. GROUNDSKEEPING

A. Landscaping

B. Identification
1. Trees
2. Shrubs
3. Grasses

C. Testing
1. Soils
2. Waters

V. DIGESTER CLEANING AND REPAIR

A. Scheduling

B. Set-up

C. Safety Procedures

D. Disposal Methods

APPENDIX L

APPRENTICE II - MECHANICAL MAINTENANCE DEPARTMENT

EQUIVALENT DEPARTMENTAL POSITION: Mechanical Maintenance Man

PROMOTIONAL POSITION UPON COMPLETION OF PROGRAM: Mechanic I

EDUCATIONAL REQUIREMENTS: Satisfactory completion of the equivalent of thirty college semester units in courses approved by the Department Head. A minimum of fifteen units must be in trade associated courses.

DEPARTMENTAL TRAINING PROGRAM DETAIL: The Apprentice II shall receive training to the extent that he can demonstrate he has achieved the level of proficiency required in each of the following categories of stationary and vehicular equipment:

I. PREVENTATIVE MAINTENANCE

   A. How

   B. Why

II. TUNE-UP

   A. Carburetors

   B. Regulators

   C. Distributors

   D. Magnetos

   E. Coils and Wiring

   F. Valve Trains

   G. Compression Testing

III. MECHANICAL FUNDAMENTALS

   A. Gearing

   B. Transmissions

   C. Engine Functions

ERIC

D. Drive Lines

E. Couplings

F. Governors

IV. PNEUMATICS AND HYDRAULICS

A. Regulators

B. Compressors

C. Pumps

D. Valves

V. HEAT RECOVERY

A. Boilers and Pressure Vessels

B. Heat Exchangers

VI. FRONT END ALIGNMENT

A. Brakes

B. Steering

APPENDIX M

APPRENTICE II - ELECTRICAL MAINTENANCE DEPARTMENT

EQUIVALENT DEPARTMENTAL POSITION: Electrical Maintenance Man

PROMOTIONAL POSITIONS UPON COMPLETION OF PROGRAM: Electrical Technician I or Instrumentation Technician I

EDUCATIONAL REQUIREMENTS: Satisfactory completion of the equivalent of thirty college semester units in courses approved by the Department Head. A minimum of fifteen units must be in trade associated courses and include the following subjects:

1. Electronics
2. Physics
3. English
4. College Math

DEPARTMENTAL TRAINING PROGRAM DETAIL: The Apprentice II shall receive training to the extent that he can demonstrate he has achieved the level of proficiency required in each of the following categories:

I. BASIC ELECTRICAL PRINCIPLES

   A. Safety

   B. Use of Tools and Equipment

   C. Mechanics of Work

II. PLANT SERVICE AND TRANSFORMERS

   A. Installation

   B. Hook-up and Testing

III. MOTORS

   A. Service

   B. Repair

IV. SWITCH GEAR

A. Circuit Breakers

B. Transfer Switches

C. Distribution System for each Plant

V. GENERATORS

A. Service

B. Repair

VI. CONTROL CIRCUITS

A. Service

B. Repair

VII. ELECTRICAL CODE AND DRAWINGS

A. State and National Code

B. Single Line Drawings - Read and Draw

VIII. METERING

A. Basic Operation of Metering Elements

B. Servicing

IX. TELEMETERING

A. Leased Line Signal Transmission

B. Conversion of Metering Signals for Transmission

C. Coding and Decoding Tone Signals

APPENDIX N

APPRENTICE II - OPERATIONS DEPARTMENT

EQUIVALENT DEPARTMENTAL POSITION: Plant Operator I

PROMOTIONAL POSITION UPON COMPLETION OF PROGRAM: Plant Operator III

EDUCATIONAL REQUIREMENTS: Satisfactory completion of thirty college semester units in courses approved by the Department Head. Courses must be acceptable for a Bachelor of Science Degree in a technical field.

CERTIFICATION REQUIREMENT: The Apprentice II will be expected to take the California Water Pollution Control Association's Operator Certification Examinations as he becomes eligible. He must have achieved the certification level currently required for Plant Operator III before he can be considered as eligible for promotion to that position.

DEPARTMENTAL TRAINING PROGRAM DETAIL: The Apprentice II shall receive training to the extent that he can demonstrate he has achieved the level of proficiency required in the following program which is divided into two distinct phases; the "What" and the "Why". These phases will run concurrently and scheduling conflicts between the two will be held to an absolute minimum.

I. "WHAT" PHASE

A. The "what" training will consist of operating a shift and performing the duties required of plant operators. At first, the Apprentice II will not be expected to stand an operating shift alone, however, every effort will be made to train him to this level as rapidly as possible.

B. This phase will require about 400 man days during the two year Apprentice II program and will be accomplished at the rate of four days per week, or about 50 man days per quarter. The Apprentice will rotate assignments each quarter and the time spent, as tabulated below, should be accomplished in blocks of 50 man days:

1. Plant #1 150 Man days

2. Plant #2 150 Man days

3. Chlorination Station 50 Man days

4. Others 50 Man days

   a. Control Center
   b. Activated Sludge
   c. Centrifuge
   d. Miscellaneous

C. In each quarter, approximately half of the Apprentices' time will be on the day shift, and the other half on an a.m., p.m. or week-end shift. Since schooling is considered an integral part of the program, shift schedules will be adjusted so as not to interfere with classes.

D. Proper reporting procedures and record keeping will be stressed in each assignment.

II. "WHY" PHASE

A. This phase will consist of 100 man days of work and will in general be accomplished at a rate of one day each week. The 100 days will be distributed approximately as follows, by subject matter:

1. HEADWORKS

   a. Screening
   b. Grit Removal
   c. Pumps

2. PRIMARY TREATMENT

   a. Sewage - Composition and Chemistry
   b. Sedimentation Basins

3. DIGESTION

   a. Types
   b. Processes
   c. Equipment

4. UTILITY SYSTEMS (Control, Treatment & Distribution)

   a. Gas
   b. Water
   c. Air
   d. Electrical

5. SLUDGE HANDLING

   a. Pumping
   b. Drying
   c. Centrifuging
   d. Filtering
   e. Metering

6. SECONDARY TREATMENT

   a. Trickling Filters
   b. Activated Sludge
   c. Processes
   d. Equipment and Controls

7. CHLORINATION

   a. Uses
   b. Safety

8. BOOSTER STATIONS

   a. Operation
   b. Controls

B. A week in advance of the day the "Why" project is to be performed, the Control Center Operator (CCO), who is assigned as the rotating day CCO, will assign the subject matter. The project will deal with the why of the particular assignment. The assignment may consist of a drawing to be studied or text material to be read. It may be learning the piping of a digester, testing a clarifier for short circuiting, trouble-shooting a process, or running an experiment, etc.

C. On the completion of each day of the "why" project the Apprentice will submit a written report of the work to the CCO who will review the report, discuss it with the Apprentice, and then forward it through adopted procedures for his permanent file.

III. REFERENCES

MOP'S of the Water Pollution Control Federation will be considered the basic texts. Where necessary, other will be used to include trade literature, DuPont courses, or manufacturers literature.

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APPENDIX O

APPRENTICE II - LABORATORY & RESEARCH DEPARTMENT

EQUIVALENT DEPARTMENTAL POSITION: Laboratory Technician I

PROMOTIONAL POSITION UPON COMPLETION OF PROGRAM: Laboratory Technician II

EDUCATIONAL REQUIREMENTS: Satisfactory completion of thirty college semester units in courses approved by the Department Head. Recommended courses of study are as follows:

I. Courses Preferred by Laboratory*

		Units
A.	English 1A	3
B.	Chemistry 1A	5
C.	Chemistry 1B	5
D.	Quant. Analysis 5A	4
E.	Microbiology 2	4
F.	College Algebra & Elem. Functions	3
G.	Electives	6
	Total	30

II. Minimum College Courses Acceptable*

		Units
A.	English 1A	3
B.	Chemistry 1A	5
C.	Microbiology 2	4
D.	Intermediate Algebra D	3
E.	Electives	15
	Total	30

*Orange Coast College catalog numbers. Laboratory experience may be substituted for some required courses; however, 30 units are required.

DEPARTMENTAL TRAINING PROGRAM DETAIL: The Apprentice II shall receive training to the extent that he can demonstrate he has achieved the level of proficiency required in each of the following categories:

I. GOALS

A. Good laboratory technique
B. Ability to set up and manipulate mathematical formulas
C. Understanding of bacteria and methods of isolation
D. Ability to use microscope effectively
E. Ability to perform all routine analyses
F. Preparation and standardization of reagents
G. Ability to keep good records
H. Ability to write comprehensive reports
I. Good laboratory safety and housekeeping practices
J. Experience with instrumental analysis

II. WORK CATAGORIES

A. Sampling

1. Beach
2. Other

B. Sludge analysis

C. Sewage analysis

1. Routine
2. Special

D. Bacteriology

1. Routine
2. Bacterial examination

E. Chlorination (demands and residuals)

F. Quantitative analysis

G. Solutions

1. Preparation
2. Standardization

H. Special Work

1. Analyses
2. Report writing

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I. Instrumentation

1. Analyses
2. Maintenance

J. Record keeping and requisitioning of supplies.

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APPENDIX P

APPRENTICE II - ENGINEERING DEPARTMENT

EQUIVALENT DEPARTMENTAL POSITION: Engineering Aide I

PROMOTIONAL POSITION UPON COMPLETION OF PROGRAM: Engineering Aide II

EDUCATIONAL REQUIREMENTS: Satisfactory completion of thirty college semester units in courses approved by the Department Head. Courses must be acceptable for either a Bachelor of Science Degree in Engineering or an Associate of Arts Degree in Engineering Technology. A minimum of twenty units must be in mathematics and/or the physical sciences.

DEPARTMENTAL TRAINING PROGRAM DETAIL: The Apprentice II shall receive training to the extent that he can demonstrate he has achieved the level of proficiency required in each of the following categories:

I. GENERAL

A. Engineering Administration and Filing
B. Record Drawings
C. Contract Shop Drawings
D. Contract Progress Payments
E. Contract Drawings

II. SURVEYING

A. Topographic
B. Traverse
C. Construction

III. INSPECTION

A. Concrete
B. Structural Metal
C. Machinery
D. Pipe Systems
E. Yard Pipe
F. Electrical
G. Coatings

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IV. DESIGN

A. Drawings
B. Specifications

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TRAINING PROBLEMS AND NEEDS OF THE LOCAL LEVEL

SANTA ROSA, CALIFORNIA

Murray B. McKinnie
City of Santa Rosa
Santa Rosa, California

INTRODUCTION

In any discussion of "Training Problems and Needs of the Local Level" we must first put "Local Level" in proper perspective. The area that I will discuss is somewhere between suburban and rural, the city of Santa Rosa having a population of 45,000 and is the shopping hub for several surrounding counties with all the other cities in these counties being smaller than Santa Rosa. The treatment facilities vary with the size of the community and where the effluent of the plant is discharged. There are primary treatment plants with ponds, trickling filter plants, activated sludge plants and package plants of various designs.

The operation of these plants vary from little to three-shift operation. Along with this goes the great variation in funds to operate and maintain these plants and even more to the point is the variation in age of the equipment.

Problems

With this in mind, I would first like to discuss the problems confronting these cities in the operation of their plants. Trained operators are nonexistant in our area. Those that are trained have come up through the ranks and are trained only in the operation of their own plant. With salaries still well below the wages offered in the Bay Area, which is only fifty miles away, the only possibility of trained manpower for the new plant is when they hire an operator to become superintendent. This places a heavy burden on this man as he must learn the operation of a new plant and at the same time train the operators to run it. Those of you who might have run a plant will realize what a problem this superintendent faces.

With salaries low in most of these cities they are unable to compete in the local labor market for men that have had experience in fields that will transfer to the treatment field. We seldom find young men who will go to work in a treatment plant, not because of the sometimes dirty conditions, but rather because of low wages. The term *sewage* does not have the effect that it had when I first started. With pollution in the news all the time, wages seem to be the major stumbling block.

Another major problem is the educational level of the men presently operating the wastewater treatment plants. From experience in teaching, I have found that we have men with a grammar school education or less, and men who have had Junior College training. Of course, the man with the Junior College education has had little or no training in

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the wastewater treatment field. This makes for serious problems for anyone teaching a group with this variation in education. In order to keep your class together it is necessary to keep both ends of the education scale happy and feeling that they are learning. I by no means feel that the man with limited education should be left behind or dropped from the class. He needs the training, and a large portion of the time he is far more eager to learn than the man with the greater education. We are going to have to live with these men and our problem is to teach them so that they can become a greater value to their city and to themselves. Whether the teaching situation should be a formal school situation or on-the-job training, I hope that some of the other speakers at this session will help to enlighten us.

Distance between plants can also become a problem. Unless these men are motivated, travel after a day's work can become a great hardship. From my own experience, and I know you all feel the same, after a day's work that meeting we go to had better be good or we will feel we have wasted our time. If, as teachers, we can motivate the men who need training and also persuade the cities involved that it is to their best interests to help that operator we have done a good part of our job. I do not feel that this means we must pay the man extra for taking training but there are other ways a city can help out; books and tuition and the cost of his transportation are two of the ways a city might help.

We have talked about the problem of the operator, but in my experience I have found that if your lessons are interesting and meet their needs they will come to any class. Probably the major problem in our field is to get the interest of the cities. It is hard to make them realize that if their operator was well trained in not only operation but maintenance they would have a plant that would more nearly meet the requirements that were set for them and they would be able to breathe easier.

Needs

The needs of the operator are as many and varied as there are operators. It would probably be easier to state the needs of the cities and districts first. As might be expected, most cities are faced with requirements set by water quality boards or health departments which they must meet. Their major problem is therefore how to best meet these requirements at the least possible cost. This means that the person or persons they have operating their plant must be able to maintain and operate this plant at its highest efficiency. This can only be done with trained personnel.

Having had the opportunity of teaching courses in wastewater treatment for several years and presenting papers at short courses for the operator it is not a difficult job to list the needs of the operators. These range from how his plant actually operates and how he should maintain the equipment to how to make the necessary tests to tell if the plant is operating properly and if it is meeting the requirements that have been set for it. Any training presented, no matter how short, should include mathematics in its simplest form. Of a class of thirty operators, it is not unusual to find less than half who can calculate the average flow of their plant or the retention time in their sedimentation tanks.

Probably the greatest need the operator has is a teacher that is not teaching from a book but rather using the book as a guide, and with his knowledge of the theory and operation of plants can answer the questions that the operator has about his own plant. This puts a burden on the teacher as he must know each plant where his students are employed. Bringing the operators together and keeping them coming to the training sessions might present a problem but if the operator feels that the teacher has the knowledge and the practical experience that will allow his questions to be answered I feel that any operator that should be allowed to operate a plant is going to be more than willing to attend classes and learn more about plant operation.

ERIC

TRAINING PROBLEMS AND NEEDS OF THE LOCAL LEVEL

CHICAGO, ILLINOIS

Ben Sosewitz
The Metropolitan Sanitary District of Greater Chicago
Chicago, Illinois

While actual census data is not available, extrapolation of the 1968 WPCF survey (Russelmann, 1969) on operator training suggests the following:

1) There are approximately 30,000 persons performing treatment plant operator duties in the United States.

2) Of these, approximately 22,000 are certified operators.

In a report of the Federal Water Pollution Control administration entitled *Manpower and Training Needs in Water Pollution Control* (FWPCA, 1967), it is stated that 45,100 personnel are currently engaged in Water Pollution Control activities and that by 1972 it will be necessary to have 111,500 personnel so engaged.

Macy (1969) indicates that by 1972, State and local agencies will need 30,000 additional trained operators of municipal wastewater treatment plants.

The standards promulgated under the 1965 National Water Quality Act require a construction and operational response substantially greater than what has been in existence. One must conclude that between 20,000 and 30,000 additional operator personnel will be required upon completion of planned construction facilities to meet existing standards. *This suggests a substantial increase by as much as 100% in available operator personnel at a local level.*

How communities will be able to respond in fulfilling this current need is part of the problem receiving our attention today.

An examination of existing certification programs leads one to some *speculation about the quality of today's certified treatment plant operators.*

The following are summarized from the Water Pollution Control Federation survey:

1) Formal education varying from eighth grade to a four-year college degree is required in 62% of the existing programs.

2) 84% of existing programs permit experience to be credited for education.

3) 35% of existing programs permit training credit for education.

4) Where special training is required, 58% of existing programs permit experience in lieu of training.

5) For the highest class of operation, the amount of experience ranges from one to 12 years.

6) For the lowest class of operation, the amount of experience requirements is from three months to four years.

Those who have campaigned so vigorously for the mandatory certification program must be given full credit for their accomplishments. Nevertheless, *inherent weakness of programs must also be identified.* From the above, *it is evident that a large percentage of the programs having educational requirements allow for experience in lieu of education and/or training.*

Since today's treatment plant operators have difficulty in effectively dealing with their problems, one must anticipate that tomorrow's operators will likewise have similar difficulties if they will be cut from the same cloth. *Absolute minimum educational requirements must therefore be key to developing criteria for treatment plant operators of the future.*

This conclusion is drawn in spite of knowing firsthand the practical difficulties confronting plant managers and personnel technicians charged with recruitment and personnel acquisitions.

One of the most significant tools available in exercising control and influence on the quality of future operations is the civil service and merit systems. Because all too often so many public agencies do not have good civil service, many poorly trained, less qualified, and in some cases unqualified personnel are given plant operator assignments. Guaranteeing the caliber of plant operators can be much more successful where good merit systems exist. Minimum requirements and sound testing procedures can provide good screening results.

Notwithstanding the salary and status problems associated with recruiting treatment plant operator personnel, the need for sound screening procedures are essential if we are to elevate the quality of operator personnel.

Perhaps the foregoing is known to all of you. It certainly has been widely discussed within the industry in the last four years, but it bears repeating since great strides have yet to be taken if we are to respond to this crisis.

Qualitative staffing of existing plants and tomorrow's plants is the basic issue to which training addresses itself. Objectives of most programs fall in one or more of the following categories.

1) More intensive training of existing plant operating personnel in order to further develop skills and versatility.

2) Improve and upgrade the skills of personnel working in lower levels (laborer class, for example) of water pollution control work.

3) Training of personnel coming from allied or related fields.

4) Training of personnel who have basic requirements outside of experience and are newly introduced to the field.

Operating personnel are falling short of optimizing the performance of existing waste treatment plants and facilities.

There are innumerable examples of new plants recently constructed but not operating properly. In the period 1965-1967, contracts for constructing almost 1500 new wastewater plants in the United States were awarded. As these are completed, *the single biggest obstacle to their successful utilization is trained manpower.*

While there are hundreds, if not thousands, of ongoing programs, they do not so far meet the need.

In plants of all sizes throughout the country, experienced personnel are still collecting samples improperly; unable to make elemental analysis, calculate volumes and percentages properly; locate the top of sludge blankets; convert units on volume measurements and flow rate measurements; calculate weights from concentration measurements; use an analytical balance, and, certainly unable to carry out a solids balance on an activated sludge process.

The effect of deficiencies in any of these areas can be catastrophic in terms of operating results. All too often, a well-run facility discovers too late the nature of erroneous conclusions drawn from erroneous data. *We cannot solve problems until we understand them. We cannot understand problems unless we properly define them.*

In the case of one of our large facilities, we have devoted eight months of in-plant training for ten operating people just to meet such a problem. The program's first phase concentrates on ensuring that the personnel will know how to take samples, how to perform the analyses and how to make the calculations. The second phase of the program will be determining together with the participants the adequacy of a proposed mathematical model as a basis for a solids balance. Here they will determine the number of samples needed to give accurate values for mixed liquor suspended solids, return sludge solids, effluent solids; and the inherent precision of the suspended solids determination. They will also determine if the conversion of soluble BOD into suspended solids balances the oxidation of primary effluent suspended solids in the activated sludge process. The third phase will be a testing of plant operating capacity and the capabilities of the operator. This will be achieved by asking the operator to reduce mixed liquor suspended solids in one battery at a very high rate to find out what the capacity limitation on the plant for solids wasting actually is. They will also be ordered to maintain mixed liquor suspended solids within certain tolerance limits, to transfer solids between batteries, and to obtain data which will be useful in predicting how the plant will perform under different operating conditions. The fourth phase of the project will be an evaluation of the control data for plant operation.

This training project allows for approximately two months for each phase. It is directed by our own engineering and chemist personnel and guided by a consultant from one of the local university sanitary engineering departments.

While the project is being conducted at a slow pace, it is as fast as the participating personnel can work without detracting from the performance of their duties and still be worthwhile.

If the project is successful, we are confident that we will improve the plant operations, we will reduce and eliminate some of the existing unnecessary samples and analyses and add others, and we will bring existing operating personnel several steps closer to achieving the optimum capability of this plant.

While I have spent considerable time discussing this program, I want to point out that this project was a result of finally awakening to the inadequacies of experienced plant operators.

Such programs and techniques for evaluating personnel capability must be continuous if we are to identify the areas requiring training attention for existing personnel. Certainly each new process or major additions to a plant will require similarly intensive training if we are to obtain good performance.

Currently, the Sanitary District is one of many agencies conducting a FWPCA training program to expand skills of employees now not engaged in treatment plant operator work. While it is too soon to determine the results of this

ERIC

44-week program, it will undoubtedly have some positive results. The value of a program such as this in opening up horizons of skill acquisition for unskilled employees is extremely high from a career employee point of view. The quantitative and qualitative success of this program will be measured in the future. One basic problem already evident in this program is the *inability to obtain well qualified, experienced instructors.* A variety of good curriculum material is available. Good instructors are not as easily available. Efforts to train good instructors must be accelerated. Here one must recognize the type of student being educated. The only common denominator between the students is the level of his unskilled work and his interest in the programs generally.

Future programs of this type may require organization along lines more conducive to classroom progress. This will require some compartmentalization along lines of previous education.

Personnel coming from allied or related fields will undoubtedly require much different training than those referred to so far. It would appear that there will be greater ease in training a person from the water field, chemical process field, or even the aerospace field. Such programs require study and articulation so that they may be utilized when such candidates become available. This will happen when either a surplus of personnel comes into existence in the related field or when the status, image and salary of the wastewater plant operator is competitive. Efforts must be made to pursue the latter course in order to make this manpower resource significant.

Personnel coming out of the high schools or two-year college programs will also be available to the wastewater treatment field only if the general economy and labor market changes or when we make this career more attractive. But when they do become available, special programs based on their fundamental educational experience will be required to introduce them into the wastewater field.

High on the priority list of academic circles disposed to working in the field of providing operator personnel training must be the *establishment of evaluative criteria.* What is the basis for judging employees' ability to accomplish the job objective? How does one overcome the known deficiencies through specially designed training programs? What programs must be developed continuously to keep pace with the state of the art? What kinds of instructors will be required for specially designed programs? What kind of training will be available for potential instructors?

A word of caution about designing training programs on the basis of small treatment plant needs. Contrary to the view of many that large urban communities have more sophisticated operations and needs, small plants require highly skilled personnel to be efficiently operated.

Small plant performance is generally not capable of coping consistently with current standards. Small plants do not have alternative human resources available and therefore rely heavily on the one or two men serving as operators. It is therefore essential that those personnel possess a wide variety of skill if they are to get optimum performance from their plants. One must also recognize that clusters of small plants will be replaced by larger facilities as urbanization continues to sweep the country. This will affect the type of plant which will be constructed in the future in order to meet the standards of the day.

The likelihood of arriving at typical prototype training programs which are effective is remote. What would appear to have promise is the *establishment of universal pre-training programs which would cover fundamentals.* These could then be *followed by specialized programs dealing in areas of particular interest* to the plants and employees involved. *Pre-training programs might well be accomplished in the classroom. Training programs might be more successful if conducted on the job site in both classrooms and field environments.*

The challenge of solving the environmental crisis confronts many segments of our society. Each has a vital role to play. Competently trained manpower will be available only if those engaged in the educational field will be able to define the problem areas and then tailor training programs and provide trained instructors to meet the challenge.

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TRAINING PROBLEMS AND NEEDS OF THE LOCAL LEVEL

FORT LAUDERDALE, FLORIDA

Roderick W. Campbell
Director of Utilities
City of Fort Lauderdale, Florida

INTRODUCTION

I consider it an honor to be invited to participate in this panel and speak on training problems and needs of the local level on water pollution control as part of this national seminar sponsored by the Department of the Interior and Clemson University. This also involves the challenges faced by directors of utilities across the nation in meeting higher standards of water quality control demanded by the people and enacted into law or ordinance by the various levels of government from the local to the national level.

It is apparent from the seminar program that highly qualified representatives are participating in this seminar from the Federal,State and local levels of government, from great universities, and from industry. Most of all, I am pleased to note the presence of representatives from the American Water Works Association and the Water Pollution Control Federation. It is my feeling that the recognized problem of acquiring and training people to man our water pollution control facilities must be squarely

ERIC

faced and supported from the local government level. Assistance is needed from many sources but the moral responsibility of water pollution control rests within each community and not entirely in the State or Federal government level. The trend is unquestionably toward consolidation of water pollution control authorities, especially in metropolitan areas such as Greater Fort Lauderdale. As such authorities are formed, it is essential that utilities managers *sell* to their boards or city commissions the necessity of including the cost of personnel training expenses -- not as a luxury item, but as a pure business item to protect the investment in the plants' facilities, and most importantly, to protect the people's right to quality water.

In short, if this seminar would serve no other purpose than to arouse in each utility manager the desire to face his moral obligation of including the cost of personnel training in his budget, just as he includes the cost of power or chemicals, this seminar will have served its purpose.

LOCAL LEVEL - GENERAL

The City of Fort Lauderdale, the county seat of Broward County, lies on the southeast coast of Florida between Miami and Palm Beach. Our area, blessed by the tropical climate of South Florida and assured of this climate year-round by the warm Gulf Stream, has experienced one of the highest rates of growth of any metropolitan area across the nation where defense industries are not a factor. The population of the city has increased from 36,000 in 1950 to 146,000 today. Broward County's population has increased from 84,000 in 1950 to 615,000 in 1969. The city currently provides softened and filtered water to approximately 186,000 people in the central area of the County.

During the last ten years the number of sanitary sewer connections in our city has increased to a current level of approximately 16,000 and is continuing to expand its sewer systems to provide service to all citizens within its corporate limits. Furthermore, all of the wastewater presently receives secondary treatment with post chlorination as required by the Florida State Board of Health.

Recently, the Utilities Department was reorganized, placing the treatment of water and wastewater under one division superintendent; all maintenance of plants and equipment under one superintendent; and the responsibility of administrative services under another superintendent. Of considerable importance under this reorganization plan was the creation of the position of Coordinator of Training and Safety -- a full time job in a department with nearly three hundred employees. It was because of this reorganization and the creation of a Safety and Training Coordinator that our city was able to execute a contract with the Federal Water Pollution Control Federation to upgrade the training of approximately twenty wastewater plant operators from our area, utilizing our city's personnel and facilities. The classroom work in theory, chemistry, and mathematics of wastewater treatment consists of utilizing existing courses already underway in our county, sponsored by the Florida Water and Pollution Control Operators Association, the County Vocational and Technical Department, and the Florida State Board of Health.

As Director of Utilities for Fort Lauderdale, I feel our FWPCA-sponsored wastewater operators training program will be a success this year and in future years as well. But, of greater importance to me is the offer of a Federal grant for this training program, which has provided the City of Fort Lauderdale with the guidance and momentum to provide a continuing educational program for the staff members of our Utilities Department on a permanent basis. We fully intend to pursue this course with or without Federal assistance. It is interesting to note that the Police and Fire Departments of our city have, for some time, sponsored excellent and progressive educational training programs. Should the municipal water and wastewater department have less?

LOCAL LEVEL PROBLEMS AND NEEDS

We realize that wastewater training problems present a challenge throughout the nation. Some of its problems are general in nature, while others are peculiar to a particular locality. We feel there is a general need for the management of utility systems to plan their personnel training programs based on the best business principles covering management, operation and maintenance to achieve the most effective use of manpower. With the new sophisticated tools, new technology, and automation, the utilities system must be managed as a business in its most refined sense. Successful businesses pay particular attention to meeting the human needs of staff and team members, and our industry must compete with other firms with reference to salaries and fringe benefits to attract prospective employees interested in advancement in the utilities field.

SPECIFIC PROBLEMS AND NEEDS

Recruitment

No one can deny that the continuous training of utility staff members is important but, at the same time, it must be realized that the caliber of new staff members joining a utility system is an important consideration. This is the season of college football and all of us are aware of the strenuous efforts made by top college coaches to recruit outstanding players from the best high schools across the nation. Likewise, in our business, more emphasis must be placed on securing young, ambitious recruits with potential capabilities to advance in our industry. Unfortunately, the salaries offered in our particular area for prospective employees in the utilities field are not high enough for

ERIC

the responsibilities involved, thus creating a serious employment problem. Until this salary level is rectified to compete with other industries, we will be severely handicapped.

Incentives

It is vitally important that incentives be offered to all utility staff members to ensure that qualified personnel will remain with the system. We feel that pay increases should be automatically given if an individual achieves academic or training certification higher than the job requirements. Many cities pay the tuition for staff members who complete accepted college courses. More emphasis is needed in the area of incentives for higher training and education.

Availability of Teachers

In order to establish a training program, all training resources must be explored from the high schools, junior colleges, universities, local consulting engineers, and manufacturing representatives. At the same time, it is recognized that many experienced people are available in our utilities systems to teach, but unfortunately, many of them have not been trained in teaching. We believe the Federal Water Pollution Control Federation has, for some time, recognized the lack of trained instructors and is presently offering outstanding courses in this area of need. More participation in these instructor training courses is essential to ensure the success of this program.

Career Counselors

High schools, junior colleges, and universities have on their staffs career counselors to guide young people into professions and careers to match the individual's talents. There exists a great need for the leaders of our profession to work more closely with these counselors to enable them to guide young people in this field. We feel this is especially true on the high school level where many youngsters who are unable to enter college would provide an excellent source of manpower for our industry.

Job Placement Agencies

In Florida, and most likely in other states, our Florida Water and Pollution Control Operators Association has for many years provided a job placement service. Unfortunately, the person who provides this service does all the work on a voluntary basis. Although a great deal of good has resulted from this service, it is our feeling that a state agency, at public expense, should establish a job placement office to provide qualified personnel for positions available in this industry.

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Mandatory Certification

The American Water Works Association and the Water Pollution Control Federation have stressed the need for mandatory certification of water and wastewater operators for many years and have issued official policy statements in this connection. Many states still operate under a voluntary plan. Our leaders agree that mandatory certification of operators is proper and in the best public interest and we feel greater emphasis is urgently needed. I believe that the individual operator will perform his duties more efficiently and will have more respect for his position if state certification is a mandatory requirement. We feel this would create an incentive for capable young recruits to enter this field.

Combined Water and Wastewater Training

The majority of public water and wastewater systems operate under the supervision of the Director of Utilities or Manager. This is proper since it is in their realm of responsibility to manage the water cycle to meet the needs of mankind and his supporting interests. Similarly, State boards of health across the land have generally been the single responsible agency in the regulation and proper operation of water and wastewater systems. Much can be gained if the training of water and wastewater operators could be more closely unified. If it works on the local level where it really counts, more unification should be stressed and considered on the national level.

Public Relations

The American Water Works Association has a slogan *Silent service is not enough.* At the same time, it has been said that the best water or wastewater operation is one which provides a service and asks no special praise. It is our feeling that in order to build higher morale in the minds of the employees who operate our water and wastewater facilities, we must make them aware of their responsibilities and the importance of their positions in the department, as well as in the community. The local level of government could aid greatly in furthering good public relations by promoting solid educational programs whereby the general public would have a greater awareness of our contribution to their very lives. In order for us to recruit upstanding young people to seek a career in the utilities field, we must have public support and understanding.

CONCLUSION

Through this type of seminar, utilities managers will come to realize that they must stress, plan, and implement -- not only operator training programs, but also educational programs whereby every member of the staff is required to upgrade his training on a continuing basis. In our opinion, this applies not only to plant operators, but to other categories as well, including supervisors, clerical staff, maintenance and electrical workers, and others down the line. The employee who has had the advantage of special training and higher education will be more efficient in his work, will have higher morale and welcome responsibility, as well as maintain a better safety record.

Our best investment for the future of our water and wastewater industry may well be our investment in the training and education of our personnel.

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CURRENT FEDERAL ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

Dr. Allan Hirsch
Acting Assistant Commissioner Operations
Federal Water Pollution Control Administration

My assignment is to talk about the Federal role in training waste treatment plant operators.

If I had had to make this speech a year or two ago there would have been relatively little to say, because there was still relatively little that we were doing in this field. Today, however, the Federal Government is playing an active role -- we have faced up to the key part that training will play in meeting our water quality goals, and the need for Federal action in this field. Commissioner Dominick's remarks earlier this morning highlighted that.

So we are developing an active Federal program, and one which we expect to be more active in the future. At the same time, we fully recognize, of course, that the problem of operator training will not be solved by any single level of government, industry, or academia working alone. The solution lies in a fully integrated approach and that's what we are striving for.

Now let me describe what FWPCA has underway or planned as our share of that overall effort.

With respect to widescale funding support for operator training, we are relying on the Manpower Development and Training Act (MDTA). This occurs through two channels. First, FWPCA participates in the Cooperative Area Manpower Planning System (CAMPS), an interagency, intergovernmental program for training people to fill a large variety of occupations, using Federal funds. The FWPCA role is to encourage and help the States to formulate operator training projects and arrange for their funding under the CAMPS procedure. These projects include both skill upgrading of existing personnel and introduction of new people into the operator category. Over the last year, commitments were obtained for the training of over 1,200 individuals. This year we would like to see that number increased to 4,000.

An example of operator training through the CAMPS program is taking place in South Carolina. Two projects are currently underway: the City of Sumter is conducting a course for 22 operators; the Greenville County Sewer Authority is conducting a course for 21 operators. In January, the City of Newberry will begin a course. Each of these projects involves three weeks of full-time classroom instruction and 41 weeks of on-the-job training. All of these projects are being financed by MDTA funds made available to the State of South Carolina.

Second, FWPCA is involved in an operator training program under a national on-the-job training contract with the Department of Labor and the Department of Health, Education, and Welfare. This program has the same objectives as the CAMPS program -- but the administrative arrangements are different. In this case FWPCA serves as a "national contractor". This means that FWPCA can subcontract directly with States and municipalities for the training of operators on a project-by-project basis. This program too is accomplished with MDTA funds. Training for over 900 operators is anticipated through FY 1970.

The National Contract approach has considerable flexibility -- as is illustrated by two of the active projects. The first is conducted by the Metropolitan St. Louis Sewer District, and is designed to have employees trained by the time a new treatment plant opens. Twenty new employees were hired this Spring to be trained for a Fall plant opening. This project involves four weeks of classroom instruction and 40 weeks of on-the-job training. The second is conducted in the Dallas-Fort Worth area by the North Central Texas Council of Governments, and is aimed at the operators of small plants. Forty operators from small plants in that region attended a three-week classroom session in Arlington, Texas, and are now receiving 41 weeks of on-the-job training from an instructor who visits each trainee at his home plant. This, then, has been the major source of funding at the Federal level.

Another source of training is the offering of short courses by FWPCA at its training facilities located at regional laboratories. Regular schedules of courses are offered at Ada, Oklahoma; Athens, Georgia; Cincinnati, Ohio; Corvallis, Oregon; and Edison, New Jersey. These courses are conducted by FWPCA staff members and last from two days to two weeks. There is no charge for attendance While these are not directly operator training courses, many of these courses are related to the operation of waste treatment plants. A recent analysis of short course attendees revealed that about 5% of all course attendees classified themselves as waste treatment plant operators. We suspect this is low because of the presence of other categories such as "engineer" and "chemist" that a person with a degree in one of those fields would more likely check.

We have prepared one course specifically for providing instruction for persons who will train operators. This course has been presented once at Athens, Georgia. As resources become available we intend to incorporate this course in a broader instructor development program. I will have more to say on this subject later.

FWPCA is planning to extend training on technical subjects by offering a series of correspondence courses. The first of these courses concerns the use of membrane filters for bacterial analysis. This course should be available in Fiscal Year 1971.

We are also funding a limited amount of operator training activity through direct FWPCA grants. Until recently grants were limited to post-graduate training, but last year we funded four pilot operator training institutes through this mechanism. One week courses were offered at Atlanta, Georgia; Portland, Maine; Waco, Texas; and in Puerto Rico. Several other technical training grants have been aimed at curriculum development for use in operator training:

1. Sacramento State College is developing a correspondence course covering all aspects of plant operation.

2. The University of Michigan is applying programmed learning to water chemistry for use in operator training.

3. The Water Pollution Control Federation is preparing lecture guides for the training of operators in such courses as laboratory controls, mathematics, and chemistry of plant operation and industrial wastes.

Also, part of the cost of this conference was funded through a FWPCA grant.

We are exploring the possibility of cooperating with the Department of Defense in their Operation Transition -- which is aimed at providing servicemen with a marketable skill as they enter the civilian work force. Operator and technician training for the water pollution control field could easily fit into this type of program. We expect to propose a pilot project for operator training during FY 1970.

ERIC

To date, FWPCA has not been heavily involved in conducting operator training courses -- that is, in providing training opportunities which involve FWPCA instructors, materials and facilities. Nor do we foresee undertaking this role. Instead, FWPCA has emphasized a cooperative approach involving State and local governments who plan and conduct courses to suit local needs.

There is, however, one instance in which it may be appropriate for FWPCA to be involved directly in training. This would be in cases where the operators of waste treatment plants at Federal installations needed initial instruction or skill upgrading -- and appropriate training opportunities are not available.

Some Federal agencies conduct their own courses and need no assistance from FWPCA. For example, the Air Force conducts a course for operators at Sheppard Air Force Base in Wichita Falls, Texas. FWPCA staff has visited that location to explore the possibility of other Federal personnel attending, and to see what aspects of that course might be incorporated into new training programs.

However, like the municipal plant sector, there are many Federal plants whose effluent could be improved substantially by increasing the competence of the operators -- but for which no training opportunities are available. We hope to be able to begin in FY 1971 to conduct operator training courses for personnel from key Federal installations.

We feel this will help the Federal Government to show leadership in pollution control -- and will also provide us with a convenient laboratory in which to test new training curricula, materials, and methods which are being developed in conjunction with the cooperative, intergovernmental approach referred to above.

We need to seek new funding sources to support operator training at the local level. We expect to continue our heavy involvement with the MDTA program, through both the CAMPS and National Contract mechanisms. Although the Federal funds are appropriated to another agency (Department of Labor) and the actual training is carried out at the local level, putting us in the role of a broker -- helping those communities needing training to qualify for MDTA financing -- FWPCA has had to devote a considerable portion of our available staff time to this effort. Now that we have had over a year's experience with this program we can see a need in some cases for an alternate funding mechanism.

As you know, MDTA funds are aimed towards improving the job skills of the unemployed and underemployed. Normally MDTA funded training projects must involve a high proportion of the previously unemployed. I say "normally" because FWPCA has been able, at least to the present, to concentrate more on skill improvement of those already employed but who are now classified as "underemployed".

ERIC

This requirement for bringing new people into an occupation can mean that communities that badly need a training project may not qualify if they are unable to hire a large enough proportion of the previously unemployed. Many communities now have people filling all their operator jobs, but still have difficulty because the incumbents are not qualified to perform adequately. To cope with this kind of situation we need a new funding mechanism. This is not meant to discredit the MDTA program. That program exists primarily to accomplish important social objectives, i.e. the conversion of the unemployed into productive citizens. FWPCA is fully in accord with the objective and would continue to use the MDTA program wherever it is practical. We feel it is most useful in larger urban areas where the specialization of occupations within a waste treatment plant is more conducive to the development of entry-level jobs and where meaningful career ladders can be developed. There is less opportunity for this in a small plant, where an operator is more likely to have plant-wide responsibilities from the beginning. To recap, I would like to say that we plan to continue utilizing the MDTA program to accomplish operator training. If no new funds are made available to us, we will continue to rely solely on MDTA. Should another funding source be made available, and I want to discuss that next, we feel that we could meet needs that are not covered under MDTA and that we could, in general, more successfully tailor operator training projects to particular local needs.

There are Congressional proposals under consideration that would provide FWPCA with its own funding source for operator training. House-passed H.R. 4148 would authorize $62 million over a three-year period. The emphasis is on training conducted as institutions of higher education. Senate-passed S.7 would make $12.5 million available over a two-year period for a pilot program emphasizing operator training through agreements on a project-by-project basis with States, local governments and private organizations. Both of these bills reflect congressional concern that an improvement in the operation and maintenance of existing waste treatment plants be achieved. Either of these bills, or a similar bill, would authorize funds for TWPCA to fund directly individual operator training programs.

Let me turn now to instructor training. It appears that one of the serious bottlenecks in the process of increasing the amount of operator training will be a shortage of good instructors -- especially if a bill like S.7 or H.R. 4148 should pass both Houses of Congress, making substantial amounts of funds available. In fact, we are already encountering difficulties in this area with the small number of operator training projects now in operation. Oftentimes the best prospects for instructor positions are persons who have experience at plant operators, but who have

ERIC

no teaching experience. To be effective as instructors these people need training in such areas as instructional techniques, curriculum development, and lesson planning. To date, FWPCA has relied principally upon the general-purpose courses of the Area Manpower Instructor Development System program conducted by the Department of Health, Education and Welfare's Office of Education to achieve instructor development. In order to provide instructor training directed specifically towards the task of preparing wastewater treatment plant operators, and to achieve more flexible scheduling capability, FWPCA is considering the establishment of instructor development institutes within the context of financial and technical assistance to units of government and organizations conducting operator training projects.

I would also like to describe an activity which we are intensifying -- manpower planning. Its purpose is to improve the basis for formulating training and other manpower programs at all levels -- local, State, and Federal. S.7 includes a specific authorization of $2.5 million for fiscal years 1970 and 1971 for the Federal portion of such a program. Managers, planners, and educators have the problem of determining how many and what types of personnel must be trained. Also we must ask ourselves -- are we using our manpower resources as effectively as possible? To answer these questions we are adopting approaches used by private industry and the armed forces to determine their manpower and training needs.

Essentially, manpower planning involves (1) determining manpower requirements -- how many and what type of personnel are and will be needed; (2) determining manpower supply -- what resources are and will be available and; (3) identifying imbalances and formulating action programs to remedy them. To accomplish this, we plan to develop a national system which will be based upon manpower needs information developed at the State and local levels. Therefore one aspect of the overall system will be the augmentation of basic manpower planning capabilities of the States and cities.

FWPCA is establishing a small central staff to provide leadership, coordination and support of the national system. This staff will develop and disseminate planning criteria, methodologies to be employed in manpower planning, and national projections of manpower demand and supply. One task of the FWPCA staff will be to develop a manpower language which can be generally accepted for identifying occupations of the national water pollution control program. Each occupational category will be labeled and defined in terms of tasks performed, and general education and specific vocational training qualifications. A contract effort is now underway to develop this language together with staffing guides which relate the numbers and types of personnel generally needed to operate and maintain different types and sizes of conventional waste treatment plants. The staff will

ERIC

also develop methods and procedures for doing manpower planning at the State and local levels. A primary function will be to prepare national projections of manpower demand and supply. We intend that our regional offices will have the capability to coordinate regional manpower planning and to provide technical assistance to States and cities in their individual efforts. We think this cooperative effort in manpower planning will mutually benefit all the governmental agencies involved and the individuals employed in the water pollution control program. First, our training efforts should be more effective and economical as they can be planned on the basis of defined needs. Second, by having information concerning the current and future occupational structure of the overall program, we should be able to do a better job of career planning for our employees. Third, by systematically analyzing the work to be done and relating the manpower needed to properly perform it, we will be able to substantiate recommendations concerning manpower requirements. This planning, together with effective training, can make a significant contribution to the success of the national water pollution control program.

This is how we currently view FWPCA's role in this important effort. We have here at this Conference members of our training staff who are developing these programs, and we will welcome your comments and suggestions.

CURRENT STATE ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

Donald M. Pierce
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In a gathering of this kind, it is natural and fully expected that the majority of the group will have many concerns, convictions, experiences and aspirations in common. As members of an action group, we are deeply involved in a common program and its thrust and impact on one or more segments of society. This is a most valuable and essential experience. The great effort required to plan this program and bring us together will be justified if we effectively communicate what we learn and what we decide here to the problems back home -- where the real action is. We must do more than just talk among ourselves.

It is always heartening to hear someone representing the taxpayer make a public declaration on the importance of what we're doing or trying to do. We had such an experience a few weeks ago in Michigan at a public hearing on proposed Regulations for the Examination and Certification of Industrial and Commercial Waste Treatment Plant Operators. The hearing was well attended and while no one objected to the proposed regulations, neither did anyone express any great enthusiasm for their implementation until the Water

ERIC

Resources Chairman of the League of Women Voters of Michigan read a prepared statement on behalf of members of the League. The following excerpts from that statement indicate a keen appreciation of the importance of effective operational control and the pressing need for training. She stated:

> "The anticipated growth in capital facilities for sewage treatment plants necessitates that some thought be given to the problem of recruiting sufficient competent personnel for operators. Industrial and governmental efforts to meet the new water quality standard might send the operator situation to crisis proportions.
>
> "Industrial wastes vary from company to company. Industrial wastes vary greatly in nature, from being very alkaline to very acidic. Toxicity, suspended solids content, or BOD of certain waste flows may be abnormally high. Industrial wastes very often require some special treatment before they can be discharged into a receiving stream.
>
> "We ask that regulations governing the examination and certification of industrial or commercial waste treatment plant operators be reviewed regularly in accordance with new and developing technology in the field of treatment facilities.
>
> "The League will continue to work for high water quality, we will support legislation, financing, and education to help solve our growing water crisis. In the League we know that informed citizens will cast their vote in favor of measures to control and avoid water pollution. They will support expanded staffs to plan, inspect, and enforce state requirements for control and development of pollution and resources facilities."

I have quoted extensively from this statement because, in a very significant way, it demonstrates that strong support is available to sound action programs for effective operation of water pollution control facilities as well as for those involving their construction. Such support, as in this instance, is often unsolicited and as such is all the more welcome.

Now there are several aspects of this little scene at the hearing which exemplify the growing public acceptance of the importance and indeed necessity of sound management of water pollution control facilities. Anyone at all familiar with the facilities and the processes utilized in wastewater treatment recognizes quickly that they require skilled and faithful attention in the best tradition of utility management. Anything less is attended by reduction in overall efficiency, degradation of the quality of the plant effluent and loss of investment to the taxpayer or other owner.

In Michigan, as in many of the states, the importance of effective operation was recognized by the State Legislature, in some sort of a categorical fashion, when the first laws on collection and treatment of sewage were passed. The 1913 statute gave the State Health Commisioner broad visitorial and supervisory powers and responsibilities over the design, construction and operation of all facilities of this kind. Some twenty years later, a small beginning had been made to establish good operational control in municipally owned treatment plants. Spearheading this effort were the State Health Department engineers with the encouragement of the young but active sewage works association. By 1935, a voluntary operator certification program had been adopted and an annual short course for operators was held each year in conjunction with the annual meeting of this association. These were the formative years when the fundamental concepts of water pollution control were being formulated among the states and interested groups representing the sportsman, the vacationer, the businessman and others desiring quality water for their specific needs.

By 1949, the conservationist and other pressure groups had generated enough support to strengthen requirements in the State laws including the employment by each municipality of a person in charge of the sewage treatment works whose competency for such position is certified by the State Health Department. This requirement focused attention on the importance of effective operation. It provided an effective framework for administration. However, like any statute, actual accomplishment of its stated objectives depends on the strength of purpose and ability to deliver on the part of the responsible State agency and the extent and effectiveness of the supporting groups. Looking back now over this 20-year span, several landmarks and trends are readily discernible.

ERIC

1. In a general sense, the quality of operational control is directly proportional to the attitudes and programs of the responsible State regulatory agency. Strict enforcement is essential but it must be accompanied by effective communication with local officials and with operating staffs to establish the reasons for and the reasonableness of the requirements.
2. A court case, early in this period, confirmed the constitutionality of the mandatory certification requirement and the supervisory authority of the State Health Department over operation. This decision dissuaded many municipalities from their planned deferment or refusal to employ a certified operator. A trial case of this kind is very beneficial to the overall program.
3. The State regulatory agency must call for and demand a high level of performance in facility operation. A very effective requirement is the performance of meaningful physical, chemical and bacteriological tests. Such data should be used in process control and to identify and quantify deficiencies in facilities, existing or impending.
4. Regular monthly operating reports containing such information have been required from all plants since 1950. The extent and depth of the data have

increased greatly over this period as effluent requirements have become more demanding and competencies of operating personnel have risen.

5. Training programs have been extended, expanded and modified in an attempt to meet changing needs. These include annually, a two or three day regional training session related to plant processes and operations, attended by some 350 operators; a one-week laboratory training course for three or four groups of twenty laboratory technicians and operators; a twelve-week, forty-hour course in either mathematics, chemistry, or hydraulics attended by about 150 each year; and a two-day in-depth seminar on a selected subject area such as activated sewage, safety, etc.

6. Operators are encouraged to enroll in courses of particular interest and value to their peculiar and particular backgrounds and aspirations. In the earlier period, these courses were predominantly of the trade school or correspondence school variety. A few took regular college courses in a standard undergraduate program. In the last few years, more operators have turned to the 2-year technical or Voc-Ed programs but, alas, the schools are not properly prepared or geared to adequately serve these needs today. Now the operators are

becoming interested in programmed instruction for certain types of information and in other new learning techniques.

7. Assistance and cooperation of educational institutions has been extremely valuable, particularly in subject areas involving design of facilities, treatment processes and laboratory analyses. Equally important is the involvement of operators in providing instruction on operational aspects. Equipment manufacturer's representatives have also been very effective in their area of specialty.

8. The interest and concern of the Federal government in effective operational control, as evidenced by increased involvement by FWPCA during the past couple of years, holds promise of significant impact on programs at all levels. Certainly this support, both in principle and financially, is most helpful. A month or so ago, the city of Detroit began a 44 week in-plant training program for 40 operators under a national contract with FWPCA. Also, an application has been filed under the CAMPS program with the U. S. Department of Labor with the assistance of FWPCA for funds to provide on-the-job training for 120 operators in groups of 20 at six locations for a period of fifteen weeks each.

9. Training programs must include practical down-to-earth instruction geared to the specific problems and needs of the operator. Today, faced with biological aerobic treatment in most plants, with phosphorus removal and with low coliform concentrations in the plant effluents, instruction in the classroom, the laboratory and on-the-job must meet these needs.
10. The operator must earn a place of respect and dignity in the eyes of his fellow workers in the community and among the general public. No one can or will do this for him. In Michigan, his elevation to a respected and usually well-paid position has been, perhaps, a bit unusual. Here, the certified superintendent of the wastewater treatment plant is usually second in pay only to the city manager or Director of Public Utilities. He is quite well trained, resourceful and usually takes pride in his job and in his work.

The Michigan experience in several respects is illustrative of national trends. Yet each state is unique and differs from all others in its special problems and approaches. A recent survey by the Personnel Advancement Committee of the Water Pollution Control Federation of operator training programs in the United States and its territories disclosed that "there is a tremendous diversity among states in requirements that seek to establish the qualifications of personnel." The survey found that all except two states have a program of operator certification, either voluntary or mandatory and that eight of these were undertaken in 1969. Quite understandably there exists a tremendous variation in requirements and administration of programs. An equal diversity was found in operator training programs. The report states "the response indicates that 44 states have active training opportunities for operators and these have, in fact, produced at least 100 different courses which were given in 1968. The 100 courses provided 306 actual programs of instruction, logging a total of 9,516 hours.

A month ago at the workshop on operator training at Dallas, Texas, sponsored by the Water Pollution Control Federation, it was the concensus of the 70 or more people attending that there is a wide gap between what is needed and what we get today in operator performance. The states, the local governments and industry are faced with the need to strengthen the operations program in every reasonable way. The essential ingredients of effective programs are known. Effective methods for training and for administration can be developed and adapted to these needs. But Michigan, like all the states, is short of some of the needed training materials. Its educational institutions are ready and anxious to participate, but they lack curriculum, texts and teaching aids and there are not enough instructors with in-depth knowledge of operations. In this respect and in many other ways, the states need the help and resources of the Federal government and the educational establishment at all levels to help each other to help the local community and its industries to do the kind of job the public expects from us today in the operation or pollution control facilities.

CURRENT MUNICIPAL ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

Carmen F. Guarino
Philadelphia Water Department
Philadelphia, Penna.

We have entered a new era in water pollution control. The Water Quality Act of 1965 has prompted many activities nationally that are required to effectively and economically control waterborne pollution.

One vital need is proper training of wastewater plant operators. Some work has been done in this direction in the past - and done well - but from a national level, surveys by various governmental groups indicate that for present and future needs, this has not been sufficient.

Until relatively recent years, organized and effective training could only be found in several areas of the country. The number of text books that operators could read and understand were few. Notably among those few were the Texas and New York Operator Manuals. There may have been others but they were not generally available.

However, this has changed. The pendulum is swinging the other way. Surveys conducted by the Department of the Interior reported in August 1967 that whereas 3600 scientists, engineers and related professionally trained personnel are now employed by State and local agencies, 9000 will be needed in 1972. This is an increase of 150%.

The survey also reports that 2600 technicians were employed and this figure must increase by 150% to meet the needs in 1972. The reports go on to state that based on authorized increases in Federal financial support for water pollution control facilities, the 20,000 treatment operational personnel will need to be increased by 10,000 in 1972 and, finally, an additional 50,000 persons will be required to maintain existing and new treatment facilities. Comparable increases in personnel were also predicted for industrial waste treatment plants.

Even though some of us may question whether these numbers are correct, I believe it is safe to state that sizeable increases in wastewater personnel will be needed in the not too distant future. It is also now being recognized that this field of water pollution control is a speciality and that an ad in the local paper will not draw many applicants.

The Federal Government, through the Department of the Interior, Department of Labor, and Department of Health, Education and Welfare, has made funds available to initiate wastewater operator training.

Many papers presenting the ideas of knowledgeable people have been written and published. Numerous outlines for operator training have been presented. High level operator Workshops are being conducted. Notable among these was the recent Workshop in Dallas, Texas, and the one which we are attending today.

All the information and ideas which are now being made available - coupled with sufficient funds and capable people to make use of the funds and information - will accomplish the objective; that is, better operators, better wastewater plant operation, and a reduction in water pollution.

Today, I would like to do several things.

1) Present to you the results of a survey that I have recently conducted.

2) Briefly describe some unique training programs already in use.

3) Tell you something about the Federally sponsored operator's training program which was started in Philadelphia this past September 29th.

4) How Philadelphia meets its needs considering that it does have three treatment plants that have been in operation before and during the water pollution control "Renaissance." I have reason to believe that most municipalities meet their needs in much the same fashion as Philadelphia.

5) Finally, some general comments concerning my feelings toward training needs.

SURVEY RESULTS

Although I am well aware of municpal activities in the state of Pennsylvania, my knowledge of municipal activities nationally was limited. In order that I would be able to present some data which would give the national picture, I conducted a questionnaire survey. The questionnaire was simply to elicit a good and rapid response. I am sure that many here have received these questionnaires and I am happy to report that virtually all that were sent out were returned answered.

Table 1 will give you a nationwide view of the areas covered in the survey. Seventeen (17) states were canvassed.

Table 2 shows a completed questionnaire. This questionnaire was completed by Columbus, Ohio, personnel. Their municipal treatment facilities serve 750,000 people. They have three treatment plants and the capacity of their largest treatment plant is 120 million gallons per day. The largest plant uses the secondary treatment process. The total number of operators employed is 165.

They have an In-Service training program and also have State training. They have indicated that present training, salaries, and operator qualifications are not satisfactory.

In answer to the question "Is Operator Certification mandatory?" the answer given here is "No". However, this is an error since Ohio has one of the best Mandatory Certification requirements I have seen. I believe the person filling out the questionnaire meant that all operators were not required to be certified, only those who are in responsible charge. This points out the need for proper evaluation of questionnaires.

TABLE I

CITIES SURVEYED

Boston, Mass.	Minneapolis-St. Paul, Minn.
Albany, N. Y.	Sioux City, Iowa
Sayreville, N. J.	Omaha, Neb.
Washington, D. C. (suburban)	Oklahoma City, Okla.
Philadelphia, Pa.	Dallas, Tex.
Pittsburgh, Pa.	Houston, Texas
Jacksonville, Fla.	Phoenix, Ariz.
Cleveland, Ohio	Seattle, Wash.
Columbus, Ohio	Walnut Creek, Calif.
Cincinnati, Ohio	Oakland, Calif.
Detroit, Mich.	San Francisco, Calif.
Chicago, Ill.	Los Angeles, Calif.
St. Louis, Mo.	Fountain Valley, Calif.
Kansas City, Mo.	San Diego, Calif.

TABLE 2

QUESTIONNAIRE

1) Municipality, Township, Authority Columbus, Ohio

2) Population Served 750,000

3) No. of Treatment Plants 3

4) Capacity of Largest Plant 120 MGD

Type of Treatment: Primary___ Secondary X Tertiary___ Other___

5) Total No. of Operators Employed (All Plants) 165

6) Operator Training: None___ In-Service X State Training X

Federal Training___ Other___

7) Is Training Satisfactory? For Present Needs No

For Future Needs___

8) Are Present Operator Salaries Satisfactory? Yes___ No X

9) Do Present Operators Have the Proper Qualifications and Backgound to Meet the Needs of the New Water Quality & Effluent Requirement Standards?

Yes___ No X

10) Does Your State Require Mandatory Operator Certification?

Yes___ No X

Additional Comments

In our large plants, we find that our training inadequacies are not in the area of information, nor of available technology. The proglem is to find "the handle" to create the necessary work attitude and job interest to properly perform the job of sewage plant operation.

The comments I received are very interesting. I would like to read this one to you. "In our large plants, we find that our training inadequacies are not in the area of information nor in available technology. The problem is to find "the handle" to create the necessary work attitude and job interest to properly perform the job of sewage operators." So you see, indoctrination is an integral part of operator training.

Rapidly looking through Table 3 will give you an idea of the type of municipalities surveyed. Most of them are large, consequently, any conclusions reached by this survey would not necessarily apply to smaller municipalities. However, we cannot overlook the fact that these municipalities serve a population of 48,436,000, which is approximately 41% (1) of the sewered population of the United States.

It is also interesting to note that in most of the large municipalities, twenty-one out of twenty-nine have primary treatment plants. This too is an indication of the additional and advanced training that will be required as the primary treatment plants become secondary plants.

There is a big difference in the operation of a primary versus secondary treatment plant. One is purely a physical treatment process while the other, that is, secondary treatment, involves living organisms and a lot more "know how".

Summarizing. Twenty-nine municipalities responded. Eighteen stated that salaries were satisfactory. Twenty-three

TABLE 5

OPERATOR TRAINING INQUIRY

Municipality	Population	Type of Plant	Training	Satisfactory Now	Satisfactory Future	Salaries Satisfactory	Qualifications
Oakland, Cal. East Bay District	608,000	Primary	In-Service	Yes		Yes	Yes
Walnut Creek, Cal. Centra Contra Costa Sanitary District	275,000	Primary	In-Service Night School		Yes	Yes	Yes
Los Angeles, Cal.	3,000,000	Secondary	In-Service	Yes		Yes	Yes
Orange County, Cal	1,200,000	Primary	In-Service Apprentice Program	Yes	Yes	Yes	Yes
San Diego, Cal.	800,000	Primary	In-Service Night School	Yes	Yes	Yes	Yes
Chicago, Ill.	8,500,000	Primary Secondary Tertiary	In-Service	Yes	No	Yes	Yes
Sioux City, Iowa	100,000	Primary	In-Service	Yes	Yes	No	Yes
Detroit, Michigan	3,000,000	Primary	In-Service (Federal Tr.)	Yes	Yes	Yes	Yes
Washington Suburban Sanitary Comm. Maryland	1,100,000	Secondary	In-Service (Federal Tr.) (State Tr.)	Yes	Doubtful	Yes	Yes
Comm. of Massachusetts Metropolitan District (Boston)	2,400,000	Primary	(State Tr.) (Federal Tr.)	Yes		No	
Minneapolis-St. Paul Metropolitan San. Dist.	1,366,600	Secondary	In-Service (Vocational Schools)	Yes		Yes	Yes

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TABLE 3 (CONTINUED)

OPERATOR TRAINING INQUIRY

Municipality	Population	Type of Plant	Training	Satisfactory Now	Satisfactory Future	Salaries Satisfactory	Qualifications
Kansas City, Missouri	670,000	Primary	In-Service (State Tr.)	Yes	Yes	Yes	Yes
St. Louis, Missouri Metropolitan Sewer Dist.	1,400,000	Primary	In-Service (Federal Tr.)	Yes		Yes	Yes
Omaha, Nebraska	400,000	Primary	In-Service		Yes	Yes	50% Appr.
Middlesex County, N.J. Sewerage Authority	500,000	Primary	In-Service	Yes		Yes	No
New York State	9,200,000	Primary Secondary Tertiary	In-Service (State Tr.) (Federal Tr.)	Yes	No	No	Yes
Cincinnati, Ohio Metropolitan Sewer Dist.	936,000	Primary	In-Service	Yes		Yes	Yes
Cleveland, Ohio	1,300,000	Secondary	In-Service (Federal Tr.)	Yes	No	No	Not in all cases
Columbus, Ohio	750,000	Secondary	In-Service (State Tr.)	No		No	No
Oklahoma City, Okla.	400,000	Secondary	In-Service (State Tr.)	Yes	No	Yes	Yes
Dallas, Texas	875,000	Primary Secondary	In-Service (State Tr.) (Federal Tr.)	No	No	No	No
North Central Texas Council of Gov'ts. (Includes Dallas)	2,200,000	Primary Secondary	In-Service (State Tr.) (Federal Tr.)	No	No	No	No

TABLE 5 (CONTINUED)

OPERATOR TRAINING INQUIRY

Municipality	Population	Type of Plant	Training	Satisfactory Now	Satisfactory Future	Salaries Satisfactory	Qualifications
Houston, Texas	1,250,000	Secondary	In-Service (State Tr.)	Yes	No	No	Yes (25%)
San Francisco, Cal.	750,000	Primary	In-Service	Yes	Yes	Yes	Yes
Pittsburgh, Penna.	1,230,000	Primary	In-Service	Yes		Yes	Yes
Philadelphia, Penna.	2,500,000	Intermed.	In-Service (State Tr.) (Federal Tr.) (University)	Yes	No	No	Yes
Seattle, Washington	875,000	Primary	In-Service	Yes	Yes	Yes	Yes
Phoenix, Arizona	650,000	Primary	In-Service (State Tr.)	Yes	No	No	Yes
Jacksonville, Fla.	200,000	Primary	In-Service (State Tr.)	No	No	No	No

of the twenty-nine stated that the operators had sufficient training to meet present needs. However, only nine indicated that the presently employed operators had sufficient training for future needs, but twenty of the twenty-nine felt the present operators possessed the proper qualifications and background to meet the needs of the new water quality standards and effluent requirements.

All but one of the municipalities - Boston - reported "In-Service Training". This is to be expected since operators are continually being replaced and, to date, the number of experienced operators available for employment would be next to zero.

Twelve reported some type of State sponsored training. Although only four of the surveyed municipalities stated they had Federally-sponsored training. Recent correspondence from the Federal Water Pollution Control Administration reports that the Federal Government has, or is, in the process of subcontracting for the training of 960 operators in nineteen states.

UNIQUE TRAINING PROGRAMS

Notably among the municipalities surveyed is the apprenticeship program at Orange County Sanitation District, California (2). (See pages 13 to 52 of these proceedings for a discussion of the Orange County program.) This is certainly a new approach. It appears well planned to eventually produce seasoned operators for every level from the men who operate the pumps through the mechanics who service the equipment to the man who will be in responsible charge of a treatment plant.

This program is designed to avoid the pitfalls of many training programs by starting with qualified personnel and phasing the program over an extended period of time which I understand would be two years for completion of the Apprentice I program, and an additional two years for the Apprentice II program in one of the specialities of wastewater operation.

Another new approach to wastewater operator training is the correspondence type which was reported by Mr. William Dendy of the Santa Ana Watershed Planning Agency and Dr. Kenneth Kerri (3) of Sacramento State College as well as Dr. John H. Austin of Clemson University (4). These courses will fill a need since there are many operators who, because of location or time, cannot attend scheduled classroom courses.

One of the most ambitious operator training programs planned is reported by Mr. William Sexauer who heads the Minnesota Pollution Control Operator Training Unit (5). They are using the Regional Operator School approach and a traveling instructor. Briefly, the program requires the instructor to conduct classes at four locations one night per week for 2-1/2 hours at each location. At the end of 50 classroom hours which cover a 20-week period, he moves to four new locations. While teaching in an area, he is required to provide on-the-job instruction to each of his students.

I also wish to report the work of the Pennsylvania Public Service Institute in furnishing training for wastewater operators. This agency is part of the Pennsylvania Department of Education and is the recognized training agency in Pennsylvania for wastewater operators.

It is funded 50% by the State and 50% by the Federal Government through the Vocational Education Act of 1966. I believe this is an Act that most States have not fully exploited for operator training. At no cost to the individual, the Institute provides an instructor and course materials. To give you an idea of its scope, in fiscal '69, 48 classes were held throughout the state of Pennsylvania covering all areas of treatment. A total of 982 students were enrolled and the courses were usually held three hours a night, one night a week, for periods as long as fifteen weeks. At the present time, 22 classes are in session at various locations throughout the state of Pennsylvania.

FEDERAL TRAINING IN PHILADELPHIA

The Philadelphia Water Department is presently engaged in a Federally-sponsored education program for wastewater treatment operators. Pennsylvania, I understand, is the first state to receive Federal funds through the Federal Water Pollution Control Administration to initiate a program to improve the skills of the present wastewater treatment operators.

Philadelphia's Water Department is working jointly with the Pennsylvania Public Services Institute. A contract with the Federal Government provides approximately $40,000 to train 40 operators. The money is to pay the salaries of two full time instructors, specialists, and the miscellaneous operating expenses.

We found recruiting instructors a difficult task. This is to be expected when you consider the shortage that exists today for all specialists in the field of water pollution control. Finding a qualified instructor who is willing to take a one year contract limits the number of candidates.

For several months, it appeared that Philadelphia, in order to meet its commitment to train 40 operators under this Federally-sponsored program, would be required to use Water Department employees who already were carrying full workloads.

Fortunately, we were able to find one capable instructor who, using the general outline provided by the FWPCA, assembled a course program and our first class was conducted on September 29, 1969.

Very recently, we were successful in recruiting a second instructor. The subject matter covered in the outline furnished by the FWPCA is broad in scope. It covers communication, mathematics, drafting, and science, in addition to wastewater operation, theory and practice. I believe that we all would agree this is quite a challenge to an instructor.

We are conducting two classes of twenty trainees each and the program in Philadelphia is entering the second month. The implementation of this program is the subject of this portion of my report.

Once a capable instructor was acquired, a class schedule for two separate classes that could easily fit in with our master rotating shift schedule had to be devised.

The Federal program suggested a three-phase schedule.

Phase I - Would be three weeks of classroom instruction conducted on an eight-hour day, five day per week basis for a total of 120 hours of instruction.

Phase 2 - Would consist of twenty-six weeks of part time on-the-job training and part time classroom instruction; divided as follows: Eight hours per day, four days per week for twenty-six weeks of on-the-job training with the instructor, and one 8 hour day per week for twenty-six weeks in the classroom.

Finally -

Phase 3 - Would consist of approximately 560 hours of on-the-job training with the instructor. This is equivalent to fourteen weeks and would complete the program.

There were many reasons why Philadelphia had to alter the suggested schedule. First, plant operations are too demanding to permit us to have our operators away from their stations for eight hours a day for as long a period as three weeks. It was also felt they would rapidly become saturated with classroom work and a good deal of the day would be wasted. Second, the suggested three-phase program was difficult to schedule for the entire length of the program. Third, the 1400 instructor on-the-job training hours requirement, with each trainee receiving approximately 71 hours each, made it necessary to prepare individual on-the-job training rosters for each trainee.

The 40 trainees are divided into two groups of 20. The groups are referred to as Group "A" and Group "B". Each group attends sessions conducted every other day with the exception of weekends and holidays. They meet four hours from 8:00 A.M. until 12:00 Noon. Each trainee will receive twenty hours of institutional instruction in a two week period and the classroom instruction will last for approximately 32 weeks without any change in schedule.

The on-the-job training is rostered weekly by the instructor for each trainee and is announced in class one week in advance.

Any time lost because of illness, vacations, etc., will be made up during the last twelve weeks of the program.

Each instructor is rostered to teach every day that a class is in session. Since subjects are taught for two hours a day and there are two subjects always being taught, each instructor is required to teach for two hours and devote the remaining six hours to on-the-job training the rostered trainee. Both instructors report for class every morning. If one is absent, the other will teach in his place.

The major difference between the suggested Federal program and the program being conducted in Philadelphia is the scheduling, which spreads classroom instruction over a longer period without any change in the number of hours for the trainees. This allows for the subject to be fed in smaller and more readily absorbable portions. We feel this is beneficial to the trainees.

In addition to the two instructors, we will also use the city of Philadelphia Water Department personnel to teach in areas in which the instructors feel they need a specialist to strengthen the curriculum.

Table 4 shows the syllabus breakdown with the subject number, the name of the subject, and the number of hours for each subject. Special note is called to numbers XIX and XX on the syllabus. Notice the rostering of the 72 hours of on-the-job training as a regular scheduled activity. Number XX shows 40 hours of Review and Career Development. During

TABLE 4

CURRICULUM OUTLINE

No.	Course Outline	Hours
I	Orientation - Water Supply - Wastewater Control	4
II	Orientation - Wastewater Treatment Plant	4
III	Arithmetic Development	24
IV	Communication Development	32
V	Science Development	34
	Chemistry - 12 Physics - 12 Biology - 10	
VI	Measurement and Drafting Development	20
VII	Fundamentals for Plant Operators	30
VIII	Treatment Plant Equipment and Plant Electricity	20
IX	Treatment Plant	20
X	Treatment Plant Unit Operations	20
XI	Laboratory	20
XII	Plant Maintenance	10
XIII	Materials and Supplies	10
XIV	Plant Records and Reports	6
XV	Instrumentation	10
XVI	Plant Safety	4
XVII	Treatment Plant Design	10
XVIII	Treatment Plant Operation	40
		318
XIX	On-The-Job Training and Remedial Training	72
XX	Review and Career Development	40
	GRAND TOTAL	430

this period, the trainees will return to the classroom to comply with the contracted forty-four weeks of training.

To date, the information that we have indicates that all is going well. The students are eager, the instructors feel they are making headway, and the inspection visits by Federal and State officials have netted favorable comments. All of this, of course, makes all of us who have a part in this new program very happy and encourages us to put more effort in making this new training program a success.

PHILADELPHIA'S TRAINING PROGRAM

I now would like to relate some of Philadelphia's experiences in training operators.

Between the years 1950 and 1955, three large treatment plants were placed into operation and during the period of 1950 to date, we have hired and trained no less than 500 treatment personnel.

This was done, for the most part, by an In-Service Training Program and Operators' Guide prepared by Mr. Ralph Hoot who was Chief of Wastewater Operations in Philadelphia from 1950 until his death in 1967. Mr. Hoot was recognized as being one of the best operators in the United States.

The book prepared by Mr. Hoot, plus a continual on-the-job training program, enabled us to successfully treat billions of gallons of wastewater and survive the hundreds of problems that were encountered in the start-up and operation of Philadelphia's three large treatment plants. The book consists of approximately 250 8-1/2" x 11" pages that can readily be added to or updated as needed. This, of course, is an advantage since it prevents the book from becoming obsolete. The book explains in complete detail each piece of treatment equipment, its operation, and includes questions and answers for the operator to test his knowledge of operation. This Operators' Manual, specifically written for Philadelphia, was also the basis of promotional exams. Tables 5 to 11 show excerpts from this book.

Our In-Service Training program has been supplemented by courses given initially by Penn State University and, more recently, by the Pennsylvania Public Services Institute.

During the '50's, most of the courses were given on the Penn State campus and were from a one to five-day duration.

In 1962, this training program was altered and key municipal areas are now used as training sites. Philadelphia is one of these areas. As requested, courses are given at one of the Philadelphia treatment plants. The courses have a fixed duration but are arranged over a period of time convenient to the operators. The courses cover all the basic areas of wastewater operation from primary treatment through activated sludge to electrical maintenance.

In addition, Philadelphia routinely allows higher echelon personnel to attend specialty courses given at Manhattan College and the Taft Center in Cincinnati, Ohio.

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TABLE 5

TEN SAFETY COMMANDMENTS

1. Always obey safety rules and safe practices: If in doubt, ask your Superintendent.
2. Help your fellow employee to be as safe a worker as yourself.
3. Use the safety equipment provided, remembering that they are for your safety.
4. Take care that your clothing is suitable to the job.
5. Learn the right way to lift and never try to lift anything too heavy.
6. Never play practical jokes, for they could hurt someone.
7. Keep your footing safe - everything must have a good foundation.
8. Do not use unsafe tools or improper equipment.
9. Do not use equipment without authority.
10. Report every injury immediately and seek prompt first aid care.

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TABLE 6

ELECTRONIC PRECIPITATOR

The principal of the electronic precipitator is as follows: Dust laden air upon entering the electronic precipitator first passes a series of fine tungsten wires each carrying a charge of 12,000 volts, D.C. As a result of this, each particle of dust acquires an electric charge either positive or negative.

The charged or "ionized" particles are then led through a field of alternately charged plates, each plate carrying 6000 volts, D.C. The result is that the positively charged dust particles will deposit on the negatively charged plates while the negatively charged particles will settle on the positive plates (unlike particles attract, similar repel).

Since 80% of the dust particles will take a positive charge in the initial ionization, 80% of the dust will be attracted to the negative plates. To make these the more effective, the negative plates are installed on a slowly revolving chain and the whole "telechron" operated so that each plate passes through a reservoir of viscosine oil once each 24 hours.

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TABLE 7

AIR FILTERS TO THE BLOWERS

There are two air filters to the blowers each of which consists of two separate entities, the electronic precipitator and an oil filter of the revolving screen type. Of the two, the electronic precipitator does by far the most work. However, the oil filter was added to give additional dust removal as well as to provide standby against no filter at all in case trouble with the electronic resulted.

The purpose of the air filter to the blower is to avoid dirt and dust being blown into the inner side of the diffuser tubes and clogging them. The efficiency of the electronic precipitator is guaranteed to be not less than 85% removal, as determined by the U. S. Bureau of Standards discoloration test.

The units were installed by the American Air Filter Company of Louisville, Kentucky. Each unit has a capacity of 46,700 cubic feet per minute at a velocity of 500 feet per minute.

TABLE 8

GAS PRESSURE

The gas pressure in a sewage works digester is normally 5 to 6 to 7 inches. The pressure is usually determined by the weight of the floating cover. This is true at Northeast in Philadelphia where the gas is collected under covers equivalent to 6.75 inches of water column.

However, the gas pressure carried at Northeast is not 6.75 inches. Each digester cover at Northeast is provided with a pressure-vacuum relief and these are set to discharge at 5.75 inches of water. Hence this should be the maximum gas pressure obtained. However, during periods of excessive gas production or a sticky diaphragm, the gas pressure may exceed this slightly. Gas pressure should not, though, be permitted to exceed 6.75" of water or the floating covers will tip and damage may result. If the pressure reaches 6.5" and maximum discharge is being obtained at the waste gas burner, relief can be obtained by going to the top of the digesters removing the four bolts, lifting the cap off the P-V relief and working (lifting) the diaphragm via the exposed rod. Each PV relief will discharge 30,000 cubic feet per hour. Use a berrilium wrench for this operation. This safety wrench is on the chain in the sludge heater office.

TABLE 9

NORTHEAST W.P.C. PLANT DIGESTERS - QUESTIONS & ANSWERS

1. (Q) A digester 90'6" in diameter has a floating cover that weighs 225,000 pounds. What will the gas pressure be if there is a 3" clearance between the cover and the side of the digester?

   (A) 6.75" of water.

2. (Q) 500,000 gallons of 4% sludge are pumped into a digester in 24 hours. How many pounds of sludge does that represent?

   (A) 500,000 x .04 x 8.34 = 166,666 lbs.

3. (Q) Why the 8.34 in previous problem?

   (A) One gallon of water weighs 8.34 pounds.

4. (Q) A digester 110' in diameter has a 1' lager of gas trapped beneath the cover. How many cubic feet is that?

   (A) 9500 cubic feet.

5. (Q) Sewage gas has 625 BTU's per cubic feet. A pound of coal is equivalent to 12000 BTU's. If a sewage plant wastes 300,000 cubic feet of gas per day, how many tons of coal would that equal?

   (A) 7,814

6. (Q) At $15 a ton for coal, how much would that waste gas be worth?

   (A) $117.

TABLE 10

PUMPING STATION & GRIT - QUESTIONS & ANSWERS

1. (Q) The desired velocity in the grit channel is 1/2 foot per second. The low level rate is 48 MGD. Three channels are in service. What should be the sewage depth in the channels?
   (A) 7.0 feet.

2. (Q) Assume the sewage elevation in the high level channel is 89' while that in the low level is 73'. Assume also it costs 5 cents for power to lift one million gallons one foot. How much extra would it cost for power if 25 million gallons of high level sewage was bypassed into the low level channel?
   (A) 5 cents x 25 MG x 16 feet = $20.00.

3. (Q) In October 1953, the pumping station pumped 1171.8 million gallons of sewage at a consumption of 198,300 kilowatt hours. The total power bill for the month was $9183.70 for 1,086,000 kilowatt hours. What was the average cost per K.W.H. and how much did it cost to pump 1 million gallons?
   (A) .85 cents and $1.38.

4. (Q) The Philadelphia Electric Company demand charge for power is $1.80 for the first 100 kilowatts; $1.25 for the next 400; and $1.15 for all over that. What would be the total demand charge for a maximum demand of 1836 kilowatts?
   (A) $2216.40.

(Continued)

TABLE 10 - (Continued)

5. (Q) How much would it have cost if one additional pump was put on for one hour and the demand had gone to 2036 kilowatts?
   (A) $2246.40 or $230 to run one pump one hour.

6. (Q) The high level flow is 26 M.G.D. Two channels are in service. The depth in the channel is 4.6 feet. What is the velocity?
   (A) 1' per second.

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TABLE 11

DISSOLVED OXYGEN - BIOCHEMICAL OXYGEN DEMAND

Reactions: The key to this test is that the manganous sulfate, the alkaline KI and the dissolved oxygen react to form manganous acid (the heavy brown precipitate) with the amount of manganous acid formed being proportionate to the original DO content.

When the manganous acid precipitate is dissolved by acid an amount of free iodine also proportionate to the original oxygen content is formed.

The free iodine is titrated with standard sodium thiosulfate, using starch as indicator, and from the amount of sodium thio used, the oxygen content is calculated. The reactions are:

A) Between the manganous sulfate and potassium hydroxide

$$2MnSO4 + 4KOH = 2K_2SO_4 + 2Mn(OH)_2$$

B) Between the manganous hydroxide and dissolved oxygen

$$2Mn(OH) + O_2 = 2H_2MnO_3 \text{ (The heavy brown PPT.)}$$

C) Between the manganous acid and HCl

$$2H_2MnO_3 + 8HCl = 2MnCl_2 + 6H_2O + 2Cl_2$$

D) Between the free chlorine and potassium iodide

$$2Cl_2 + 4Kl = 4KCl + 2l_2$$

E) Between the free iodine and sodium thiosulfate

$$2l_2 + 4Na_2S_2O_3, 5\ H_2O = 4NaI + 2Na_2S_4O_6 + 20H_2O$$

Graduate work is encouraged by the payment of tuition for courses related to Sanitary Engineering taken at recognized universities at night.

Today, I have reported municipal activities in wastewater training as well as experience in initiating a Federally sponsored training program and Philadelphia's In-Service Training program.

I now would like to make one final comment. Throughout the country, we do have some excellent operators. However, I believe we all would agree there is a need to improve our skills, and there is a need for more qualified men to enter the field.

Education and training is half-a-step. Improving the operator's image and salary will complete the step.

ACKNOWLEDGMENT

I wish to acknowledge my gratitude to Mr. Robert Knox, Philadelphia Wastewater Treatment Instructor, for the assistance he has given me in the preparation of this paper.

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CURRENT UNIVERSITY ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

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INTRODUCTION

Universities are playing and have played an active role in wastewater treatment plant operator training programs of the nation. Table 1 summarizes those educational institutions listed in the "1967 Status of Operator Training and Certification in the United States" (Anon., 1968). Table 1, however, does not give the total participation of university personnel engaged in wastewater treatment plant operator training. In many states the operator training program is administered by a State agency or the local section of the Water Pollution Control Federation, and university personnel make their contribution through these organizations.

PAST PARTICIPATION

A wide variety of educational methods are used in these university-sponsored programs. The most common are one-day to one-week schools. These are held in a central location and the trainee is in residence for the duration of the school. Another type of effort makes use of a weekly or

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TABLE 1

UNIVERSITIES SPONSORING AND CONDUCTING
WASTEWATER TREATMENT PLANT
OPERATOR TRAINING*

State	University	State	University
Alabama	Auburn University University of Alabama	Nevada	University of Nevada
Arkansas	University of Arkansas	New Jersey	Newark College of Engineering
California	American River College	New Mexico	New Mexico State University
Colorado	University of Colorado	New York	Syracuse University New York State University Manhattan College Farmingdale A & T
Connecticut	University of Connecticut		
Florida	University of Florida	North Carolina	University of North Carolina
Idaho	University of Idaho Idaho State University	North Dakota	North Dakota State University University of North Dakota
Indiana	Purdue University	Oklahoma	Oklahoma State University
Iowa	Iowa State University University of Iowa	Oregon	Oregon State University
Kansas	University of Kansas	Pennsylvania	Pennsylvania State University
Louisiana	Louisiana State University	South Carolina	Clemson University
Maryland	Baltimore Junior College Hagerstown Junior College Chesapeake College Charles County Community College	South Dakota	South Dakota State University South Dakota School of Mines
		Texas	Texas A and M
Michigan	Michigan State University	Utah	Weber State College University of Utah Utah State University
Missouri	University of Missouri		
Montana	Montana State University	West Virginia	West Virginia University
Nebraska	University of Nebraska	Wyoming	Colorado University

*Anon. 1968.

bi-weekly meeting which lasts for several hours per meeting. This type of course may run for many weeks or several months. The present Cooperative Area Manpower Planning System (CAMPS) program of the Federal Water Pollution Control Administration is of this type and is conducted over a period of 44 weeks. Two states use one of the above systems and supplement the training with correspondence courses.

University staff have played an active part in the production of a wide variety of training materials including textbooks, training manuals, correspondence courses, 35 mm slide series, films and video tapes. As a sampling, one might include the *Manual for Sewage Plant Operators*, prepared by the Texas Water and Sewage Works Association (Mahlie, 1964); *Manual of Instruction for Sewage Treatment Plant Operators*, prepared by several professional groups in New York State (New York State Department of Health, no date); *Sewerage Seminar on Plant Maintenance*, prepared by the University of Colorado and the Rocky Mountain Water and Sewage School Council (Fitzpatrick, 1965); and *Correspondence Course Manual for Wastewater Plant Operators - Class D*, prepared by Clemson University and the South Carolina Water and Pollution Control Association (Austin, 1969). University staff have also assisted with the preparation of manuals of practice produced by the Water Pollution Control Federation.

A careful enumeration of the many courses and training aids produced by the profession in the last few decades would produce an impressive list and would be an indication of much of the effort devoted to operator training. But however proud we might be of this effort, we must, nevertheless, take a critical look at these endeavors. The first question we must ask ourselves as professional educators is; how effective have our training efforts been? Have these training efforts been pitched at the proper technical level for the trainee we are trying to reach? Do we use the most effective means of communication? All too often the educator decides that the trainee should have this amount of background material, and that bit of supporting material. By the time the trainee has waded through the material he often is at a loss to know just what portion of the material is pertinent to his operation. The instruction provided for a wastewater treatment plant operator must be based on what information, facts, and skills the operator needs to carry out his required tasks.

As Dr. Tiemann will explain in more detail later in these proceedings, it is not always the student that fails; it may be the instructor that fails if the student does not learn what is put before him. The education offered to a trainee must be pertinent and the methods used to educate him must be evaluated in terms of their ability to raise the trainee to an indicated proficiency level. Only when the instructional material has been developed with a desired proficiency in mind can the educator be assured that he is carrying out his responsibility. Figure 1 (Markle and Tiemann, 1966) indicates the interrelationships of job performance, instruction, and performance criterion. Feedback is necessary to have an effective training system.

A logical way to generate effective training materials for the wastewater treatment plant operator is shown in Figure 2 (Markle and Tiemann, 1966). First, the type of performance to be demanded of the trainee must be determined and behavioral objectives stated. Second, criterion tests must be delineated to establish if these behavioral objectives have been reached. Third, the educator must determine the background of the trainee in order to ascertain the type and extent of the training materials needed. Fourth, the instructional materials are prepared. Fifth, data must be collected to determine the effectiveness of the program so that given a certain entering behavior, a trainee will attain the goal that the instructional package is designed for.

Sanitary engineers in education need to draw more heavily on the talents of their cohorts in Education and Vocational Education. More cooperation here should lead to more effective training programs extending from the beginning operator to the post-graduate level. Design and operation of plants are two sides of the same coin and graduates of

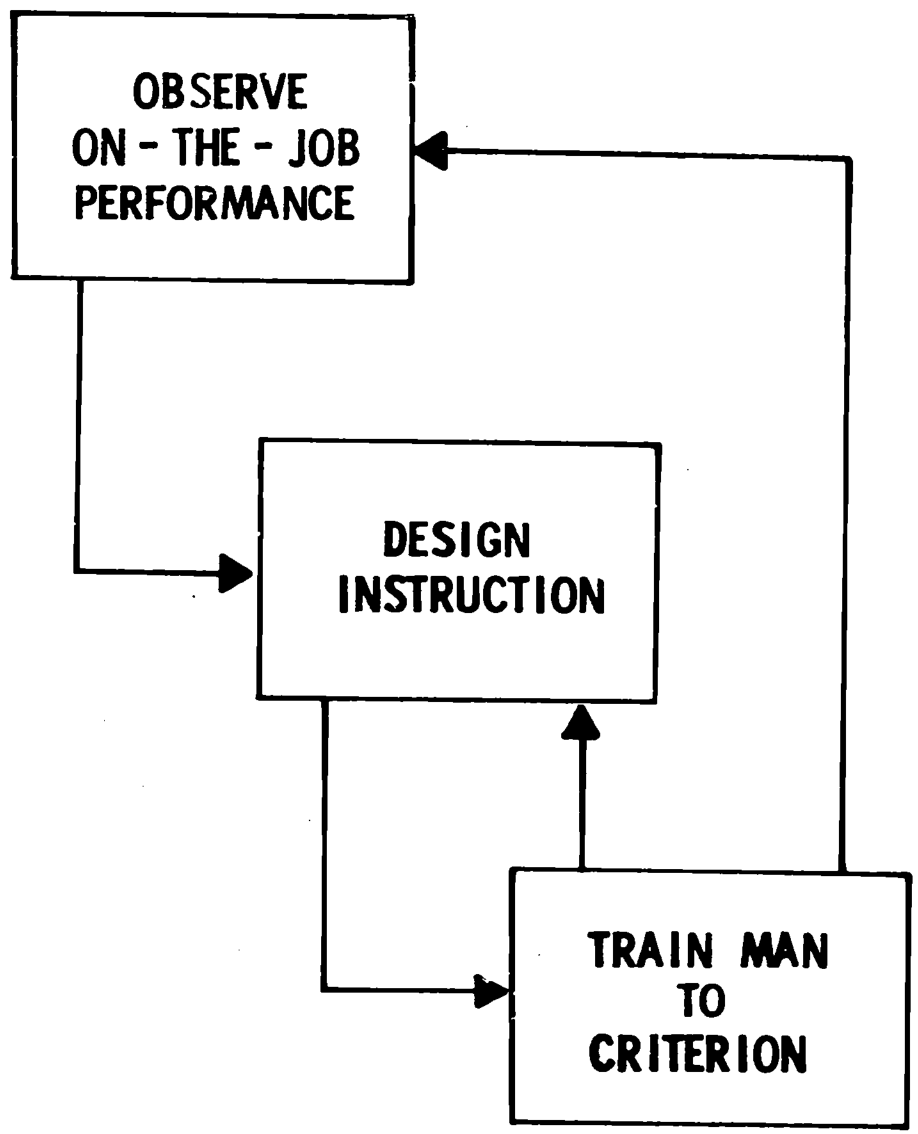

FIGURE 1. BASIC COMPONENTS OF AN EFFECTIVE TRAINING SEQUENCE

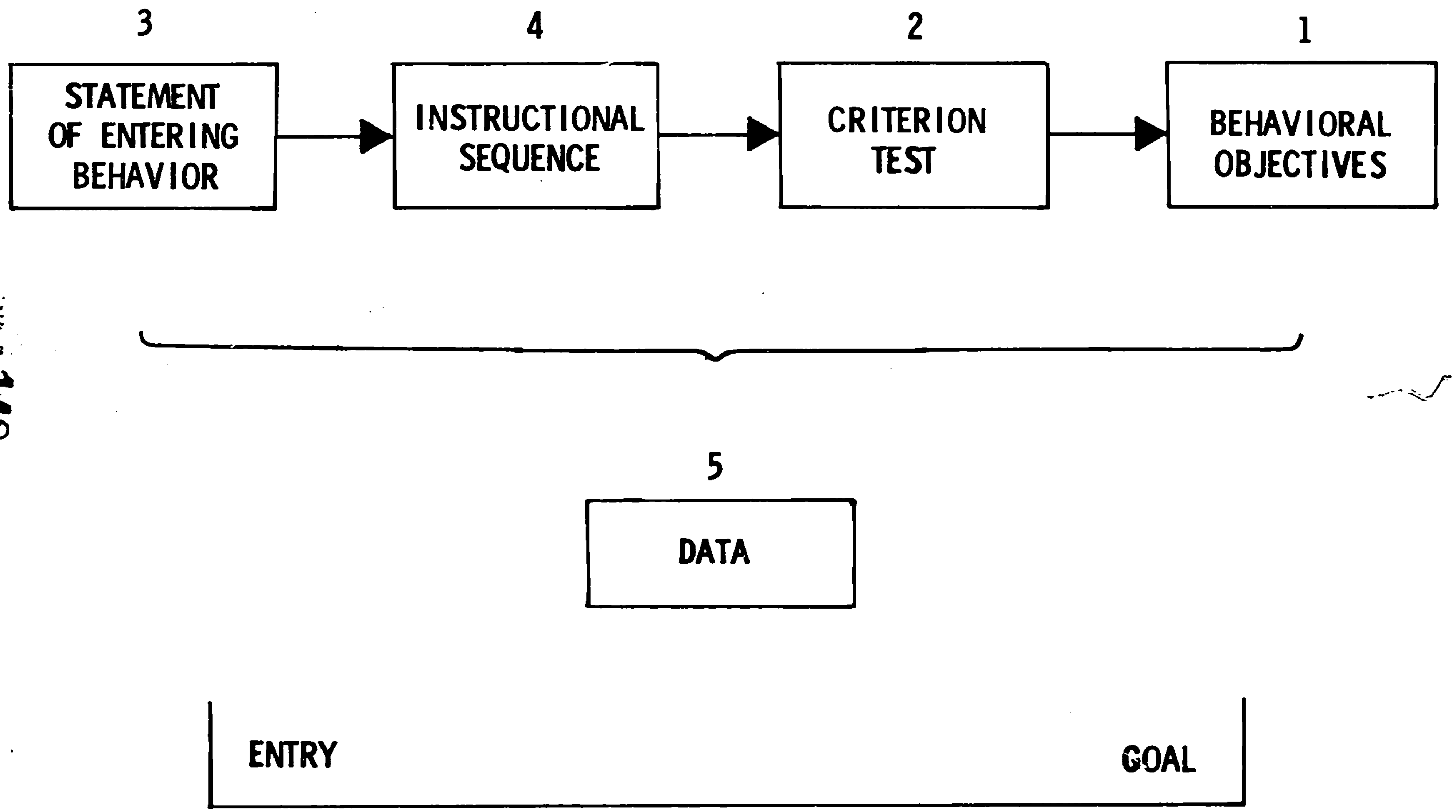

FIGURE 2. GENERATION OF A TRAINING SEQUENCE

university programs must have an understanding of the necessity for proper operation and ways this might be affected. This is not believed to be the case at present.

A second question we might ask ourselves as we study the listing of training aids is: why do we persist in repeating the same effort in each state or training organization? It would appear that a concerted national effort on operator training would be much more efficient in the use of both time and money. At the recent Water Pollution Control Federation Workshop on Operator Training (October 4, 1969) in Dallas, Texas, a proposal was made by Dr. W. M. McLellon of the Florida Technological University for the establishment of a National Advisory Council on Operator Training (NACOT). Associated with this council would be a National Center for Operator Training Information (NACOTI). The latter would serve as an information center to assist in making available to interested persons information on all training efforts underway in the United States, including distribution of some documents where appropriate to its function.

The National Advisory Council on Operator Training (NACOT) would be composed of interested, outstanding engineers, scientists, managers, operators, and others. The Council would serve as a continuing body to perform studies and evaluations of problems associated with water and wastewater treatment plant operator training, including consideration of such items as future needs, standards, and methodology.

NACOT should be jointly sponsored by WPCF and AWWA in cooperation with FWPCA and PHS. It would be a nongovernmental council, however; its activities would be largely financed by governmental grant. The Council would draw membership from the four organizations mentioned but additionally would invite representation from many other sources such as the APHA, APWA, Water and Wastewater Equipment Manufacturers Association, educational institutions, state water and pollution control associations, consulting engineers, municipalities, and others, as a partial list. Thus the Council probably would have 40 to 50 members and would draw on other persons if necessary for expert advice. A parallel case is the National Council for Radiation Protection which has been in existence under various names since the 1920's.

The Council could have a small permanent staff for administrative and operational assistance, preferably placed in Washington, D. C. The Council would meet in complete or committee sessions as determined by the membership and officers. Its function would be to provide considered, coordinated, professional advice on operator training problems extending from the national to local levels. An example would be an initial complete review of all existing training efforts and development of a national plan for training over a ten-to-twenty-year time frame. Associated with this initial work would be a definition of terms. For example what is the definition of *operator*? Another question might

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be review of existing practices and development of recommendations on standards for training of operators. The Council, as a continuing body, would provide short and long range surveillance of the overall operator training problem and would assist government by making available expert, independent advice to handle specific questions. The Council would also self-generate studies on items which it felt should be explored.

NACOTI would be an affilitated effort to provide a focal point for operator training information, including training aids. This does not exist at present, though it is understood the Consumer Protection and Environmental Health Services group in PHS is working on the information problem. The Center should cover both the water and wastewater fields and would maintain a current inventory of documents, references, and training efforts available nationally for use by interested parties. With the growth in technology, satisfactory information retrieval has become very difficult. NACOTI would greatly assist in this by accomplishing the initial and continuing search in the operator training field. Periodic dissemination of lists would be part of the effort. This is done partially now by the societies in their publications. A centralized effort would appear to be advantageous. The Chemical Abstracts are an example of such a centralized effort applied to public actions in a specific field.

The NACOTI effort could be formed with a small staff and a Director affiliated with the NACOT staff.

PRESENT PARTICIPATION

Universities continue to play an effective role in the variety of educational methods described in the previous section. In addition, several institutions have undertaken extensive programs which should make significant contributions to the training of wastewater treatment plant personnel.

Sacramento State College in Sacramento, California, was awarded an $83,000 grant in 1968 from the Federal Water Pollution Control Administration for a three-year program to develop a correspondence training program for operators of wastewater treatment plants. This is a joint effort with the California Water Pollution Control Association; thus practicing wastewater treatment plant operators, practicing engineers and University personnel will have input into the instructional material.

In 1966, the University of Michigan was awarded a $70,000 grant from the Federal Water Pollution Control Administration for a three-year program to develop a series of programed learning lessons dealing with the chemistry of analysis and treatment of water and wastewater. This effort is described by Dr. Purseglove in these proceedings.

In many of the operator training programs conducted throughout the United States the trainee is limited to one or more days of training at a school given at a particular time and place. Often the operator does little to educate himself during the periods between schools.

This was the case in South Carolina in 1952, and it was deemed necessary to provide additional instruction for operators since the school sessions were far too short to cover the necessary material. In 1952, the General Assembly of South Carolina appropriated $10,000 as a direct and contiuing annual appropriation to Clemson University to finance the preparation and administration of correspondence courses for the operators of treatment plants in the State. This resulted in correspondence courses for both water and wastewater treatment plant operators at four levels. In 1967, additional funds were appropriated for the revision of these manuals and to hire a man to visit plants and offer on-the-job advice. Revisions are making the manuals more job-oriented, with additional information and examples being included. The manuals are accompanied by a question booklet which the students complete and mail in for grading. In the past, upon successful completion of the book, the trainee received a certificate and was permitted to take the voluntary certification exam. In recent years a mandatory certification law has been passed in South Carolina. Completion of the correspondence course is not required for certification. However, it provides an excellent tool for certification examination preparation. These correspondence manuals have provided an excellent means for the water or wastewater treatment plant operator to educate himself between the annual operator training schools. Revisions of the correspondence manuals are only an interim solution to the training effort. Plans are underway to use other media such as programed learning manuals, video tapes, mailable kits, and other techniques.

An additional effort has been made to alert the operator to the many training programs available to him. A video tape was prepared at Clemson University which outlined the host of training opportunities available from the local level to the national level. This video tape was presented twice on the South Carolina state-wide educational television network and operators were alerted to the viewing time. It has also been used at State and national operator training meetings.

In order to improve the correspondence type instruction, an additional technique is under investigation at the present time. This technique incorporates the use of an audio-visual unit. Several commercial units are available. At the present time, the AUDISCAN* unit is being used. The basic component of the system is a cartridge which contains a 16 mm

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*Product of Audiscan Inc., 1414 130th Ave., N. E., Bellevue, Washington 98004.

continuous-loop film strip and a synchronized audio tape system that can be programed up to 25 minutes of sound and 225 visuals in a single cartridge. This 5-inch-by-5-inch-by 1-1/2-inch cartridge snaps into the unit and is ready for operation. An automatic stop can be programed into the unit and is ready for operation. An automatic stop can be programed into the film at any point. The film can be stopped manually if desired. The trainee presses a button when he is ready for the program to continue. This programed automatic sequence training with automatic stops and demand restarts is ideal for treatment plant operator training. A trainee can hold a picture as long as he likes, then proceed. Problems can be given and held on the screen while the trainee solves them. When the trainee is ready, he presses the start button, and proceeds. A trial film has been produced from one of the correspondence manuals. This film is devoted to "*Water and Wastewater Units of Measurement.*" Commercial companies have produced a number of units on keypunching operations and the techniques of Fortran programming as other examples of the use of this technique.

An increasing role in the training of technicians for the wastewater field will be played by two-year technical centers and community colleges of the country. Hanlon, 1969, indicates some 17 schools have programs for training these technicians (Table 2). Many of these are conducting the 44-week CAMPS program. The instructors in these programs are men with university training and several years of practical experience.

SUMMARY

The universities of the nation have played an active role in the production of training materials for the wastewater treatment plant operators of the nation as well as assisted with the operation of a variety of training schools. It is the duty of the professional educator to continually update the training materials both in technical content and in method of presentation. Efforts are underway to use programed instructional materials, video tapes, and continuous loop audio visual tapes to greatly enhance the learning process. These will complement conventional text and course material currently used in educational programs at various training levels. All persons concerned with training wastewater treatment plant operators should work for the establishment of a national organization that will coordinate training efforts.

TABLE 2

ENVIRONMENTAL PROGRAMS IN TWO-YEAR COLLEGES*

College	Curricula
Agricultural & Technical College, Morrisville, N. Y.	Water and wastewater technology
Milwaukee Technical College, Milwaukee, Wis.	Water and wastewater technology
James Connally Technical Institute, Waco, Texas	Water and wastewater technology
San Diego Junior College, San Diego, Calif.	Water and wastewater technology
Chicago City College (Southeast Campus), Chicago, Ill.	Water and wastewater technology
Monroe County Community College, Monroe, Mich.	Water and wastewater technology
Broome Technical Community College, Binghamton, N.Y.	Environmental control technology
Ferris State College, Big Rapids, Mich.	Environmental control technology
Hudson Valley Community College, Troy, N. Y.	Environmental control technology
Brevard Junior College, Cocoa, Fla.	Environmental control technology
Fayetteville Technical Institute, Fayetteville, N.C.	Sanitary engineering technology
Contra Costa College, San Pablo, Calif.	Water technology
Sumter Area Technical Education Center, Sumter, S.C.	Environmental engineering technology
Charles County Community College, La Plata, Md.	Solid wastes and wastewater technology
Essex Community College, Essex, Md.	Air pollution technology
Santa Fe Junior College, Gainesville, Fla.	Air pollution technology
Wytheville Community College, Wytheville, Va.	Environmental engineering technology

*Hanlon, 1969.

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CURRENT COMMUNITY COLLEGE ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

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La Platta, Maryland

The junior college is a product of the twentieth century. From 1902, when William Rodney Harper proposed the concept of the junior college, to the present time, over 900 junior colleges have been founded. In the past several years these colleges have been founded at the rate of one per week. The community college is now a part of the total higher education program in all fifty states, in several of the territories, and in a number of foreign countries.

The community junior college is a post-secondary educational institution offering educational programs of less than baccalaureate degree objectives. The instructional program of the community college embraces the work in the collegiate lower division required by students expecting to transfer to universities or four-year colleges, the programs for occupational education heading directly to job entry, and educational programs serving broad community interests and enrolling adults and part-time students as well as full time students.

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As an outgrowth of the technological revolution there is a vast array of semi-professional and technical positions which require two years of college study. The community college not only prepares individuals for initial employment but provides programs to retrain and upgrade those that have been displaced from present jobs or seek a speedier advancement to higher positions.

One example of a two-year program terminating with an Associate of Arts degree is that of environmental technician. In August of this year, representatives of a dozen colleges offering environmental technician programs met at a colloquium conducted in Ann Arbor, Michigan by the National Sanitation Foundation. At this colloquium the need for the training of environmental technicians and treatment plant operators was discussed, as well as the programs that are now being developed to fulfill this need.

Those attending the colloquium also discussed in detail the great difficulty which they have in attracting students into the field because of its poor image. Another problem is the high cost of occupational programs due to the low student-to-teacher ratio which is required for an effective program, the high cost of facilities for this type of training, and the difficulty which is encountered in obtaining competent instructors.

Those who attended the colloquium agreed that it is of utmost importance to have the full support, both moral and financial, of the entire water and wastewater industry if the programs are to be effective.

For the past three years, four community colleges, in cooperation with the Maryland State Health Department and Department of Natural Resources, have presented a training program for water, wastewater, and industrial wastewater treatment plant operators and superintendents. This program consists of instruction for three hours, one night per week for thirty-two weeks. The program covers training in physics, mathematics, biology, chemistry, and unit operations.

During two of these past three courses the sanitary engineer at the Charles County Community College has visited the plant of each student to give technical assistance. In general, it has been found that these operators are not able to perform the simplest treatment plant calculation. Only forty-four percent exceed the 50 percentile of ninth grade students in arithmetic when graded on a national average. Only nine percent exceed the 50 percentile in algebra. For this reason the mathematics section of this program has been revised for this lower level student with the biology and physics sections being shortened. The staff of each of the four colleges involved is now making a concentrated effort to reorganize the program.

In addition to the present state program, The Charles County Community College offers the following programs in the environment field:

1. A two-year Associate of Arts degree program in Pollution Abatement Technology centered on water pollution control.
2. A one-year Solid Waste Management certificate program.
3. Seminars of one week duration on selected subjects.

A forty-four week program supported by the Department of Labor and the Federal Water Pollution Control Administration for the upgrading of operators will be initiated this month.

Over forty percent of the courses in the two-year Associate of Arts degree program are in the general education field. These general education courses have been selected to give maximum value to the student for time invested. The technical courses, while based on water pollution control, can naturally be related to the other environmental ills.

A science and technology center with classrooms and laboratories specifically designed for this program is now under construction and will be finished by the first of the year. A wastewater treatment plant designed as a teaching facility was placed into operation at the beginning of this past month. Over 800 color 35 mm slides have been prepared or purchased. The preparation of teaching aids has been a very time-consuming project, as there have been no textbooks published on the technicial level in wastewater treatment.

As was mentioned previously, the recruitment of students has been a rather serious problem. The program has been publicized by articles in:

Water and Sewage Works

Water and Wastes Engineering

American Education

Natural History

American Girl

Advertisements have been placed in the education supplements of the *Military Times* and the *Washington Post*. Over one thousand brochures describing the program have been mailed out. The staff has presented talks to school classes as well as civic groups. During the coming year additional emphasis will be placed on student recruitment using techniques which were presented at the NSF Colloquium.

Any of the community colleges involved in operator or technician training is willing to help the employer train his personnel. We are soliciting your comments regarding the present programs which are offered.

ACTIVITIES OF THE NEOSHO WATER AND WASTEWATER TECHNICAL SCHOOL

Lloyd Caughran
Training Consultant
Neosho, Missouri

Early in 1959, contacts were made with manufacturers and suppliers of equipment for the Water and Wastewater industry. They were advised of our intentions to establish a school for the specific purpose of training people in our field. This would be the first instance where a school was established exclusively for this type of training. The enthusiastic response was very gratifying, support came from engineers, U. S. Public Health Service, state health departments and others. The school was launched in January 1960. Since that time over 2,000 people have been trained in various facets of operation.

The school has had an international flavor by having representatives of over 50 nations. At one point the school took instructors and equipment to Jamaica, West Indies to conduct training in that country.

The mechanics of training as employed by the Water and Wastewater Technical School (WWTS) are as follows:

First, the school employs typical classroom teaching.

Second, demonstrations are conducted by the instructor and finally the student performs the various functions.

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This system of hearing, seeing, and doing, we like to refer to as "total training."

The real measure of the school, or of any training, is in the ability shown by its graduates in being able to do their job acceptably. Graduates of the school are serving as operators, laboratory technicians, superintendents, public health departments, sales and various other facets of the water and wastewater service. Reports from their employers indicate a general satisfaction in the knowledge and capability of the trained employee. We feel that these results confirm the original thinking of having a school solely for the purpose of preparing operators in a practical manner.

The growth of the physical plant from the original one building to eleven buildings, plus a housing area, demonstrates the interest in this activity. The school facility includes a library, cafeteria, maintenance shop, as well as mechanical laboratories and other training areas. It is the ability to show models, cut-a-ways, or operational items that makes the WWTS unusual. The school has all types of treatment equipment, distribution and collection system items, metering devices, and a well-equipped training shop. This provides the student an opportunity to see how the equipment is operated, constructed, and maintained. The use of training aids gives a very practical approach to the training operation. This system is highly recommended to all training endeavors.

With rapid expansion of treatment facilities throughout our nation the demand for efficient practical training will continue to grow at a tremendous rate. It would seem, therefore, that a number of schools of this type would be imperative. Let me quote from an article written in a Missouri paper the past few days by Congressman Durward G. Hall.

> *The compelling need for expansion of the water resources program in the not-to-distant future is evident from the forecast of water requirements made in the first assessment of the Nation's water resources recently completed by the Water Resources Council. These findings, based on a projected population of about 468 million people in the United States by the year 2020, include the following:*
>
> 1. *Flood Control. Based on the current status of flood control works and projected conditions of flood-plain use and development, the total annual flood damage potential for the nation is anticipated to rise from $1.7 billion in 1966 to more than $5 billion within fifty years.*
>
> 2. *Water Quality--Pollution Control. Projected capital outlays required for waste treatment, sanitary sewers, and water cooling requirements are estimated at $20 billion through 1973.*
>
> 3. *Water Supply. Requirements for municipal water systems are expected to triple in less than thirty years, increasing from 24 to 74 billion gallons a day. Industrial water use will increase more than 400%. Steamelectric power requirements will increase water withdrawals from 63 billion to 411 billion gallons a day.*

A 36-weeks course of training has varied very little from the original curriculum. The one week special courses are conducted to help up-grade those currently employed. They are very important. These have been programmed for one week each month. We recommend that long term training of at least 36 weeks, and longer if possible, be considered for training operators throughout the country. Any short-cut in the training will cut short the ability of the graduate in performing responsibly in the water and waste-water industry.

Students have come from various areas and with all sorts of educational and experience backgrounds. They have ranged from engineering degrees to only partial elementary education. There are no prerequisites as to education, experience or geographical location. Some of the students have had a great deal of formal education and experience. It makes no difference, as far as the school is concerned. It is the intent of this school that these individuals will have access to knowledge and skill which will increase their value in many ways. The necessity for lifelong learning is no longer academic. It is an industrial and professional fact.

The future plans of WWTS envisions expanded operations particularly with respect to long-term training. There may be some minor variations in training content, or technique, but it is not anticipated that unusual changes will be made.

In summary, we feel that the 10 years of experience is adequate to make certain judgments in the training field for our profession. The real limitations exists only in the fact of the limited amount of good practical training operations. We should make every effort to improve and refine our technique and to broaden the scope of training operations.

LEGISLATING FOR INCREASED MANPOWER

FOR WATER QUALITY CONTROL

Hon. William C. Cramer (Florida)
U. S. House of Representatives
Washington, D. C.

EDITORS NOTE:

Mr. Cramer spoke on the manpower needs in water quality control and how HR 4148 proposed to assist in the solution of these needs. Since the workshop was held in November 1969, both houses of congress have acted on HR 4148 and the President signed it into law on 3 April 1970. Thus, those portions of HR 4148 (now Public Law 91-224) which pertain to manpower developed are reprinted here.

WATER QUALITY IMPROVEMENT ACT OF 1970

TITLE I - WATER QUALITY IMPROVEMENT

"TRAINING GRANTS AND CONTRACTS"

"Sec. 16. The Secretary is authorized to make grants to or contracts with institutions of higher education, or combinations of such institutions, to assist them in planning, developing, strengthening, improving, or carrying out programs or projects for the preparation of undergraduate students to enter an occupation which involves

ERIC

the design, operation, and maintenance of treatment works, and other facilities whose purpose is water quality control. Such grants or contracts may include payment of all or part of the cost of programs or projects such as -

"(A) planning for the development or expansion of programs or projects for training persons in the operation and maintenance of treatment works;

"(B) training and retraining of faculty members;

"(C) conduct of short-term or regular session institutes for study by persons engaged in, or preparing to engage in, the preparation of students preparing to enter an occupation involving the operation and maintenance of treatment works;

"(D) carrying out innovative and experimental programs of cooperative education involving alternate periods of full-time or part-time academic study at the institution and periods of full-time or part-time employment involving the operation and maintenance of treatment works; and

"(E) research into, and development of, methods of training students or faculty, including the preparation of teaching materials and the planning of curriculum.

"APPLICATION FOR TRAINING GRANT OR CONTRACT;
ALLOCATION OF GRANTS OR CONTRACTS

"Sec. 17. (1) A grant or contract authorized by section 16 may be made only upon application to the Secretary at such time or times and containing such information as he may prescribe, except that no such application shall be approved unless it -

"(A) sets forth programs, activities, research, or development for which a grant is authorized under section 16, and describes the relation to any program set forth by the applicant in an application, if any, submitted pursuant to section 18;

"(B) provides such fiscal control and fund accounting procedures as may be necessary to assure proper disbursement of an accounting for Federal funds paid to the applicant under this section; and

"(C) provides for making such reports, in such form and containing such information, as the Secretary may require to carry out his functions under this section, and for keeping such records and for affording such access thereto as the Secretary may find necessary to assure the correctness and verification of such reports.

"(2) The Secretary shall allocate grants or contracts under section 16 in such manner as will most nearly provide an equitable distribution of the grants or contracts throughout the United States among institutions of higher education which show promise of being able to use funds effectively for the purposes of this section.

"(3) (A) Payment under this section may be used in accordance with regulations of the secretary, and subject to the terms and conditions set forth in an application approved under subsection (a), to pay part of the compensation of students employed in connection with the operation and maintenance of treatment works, other than as an employee in connection with the operation and maintenance of treatment works or as an employee in any branch of the Government of the United States, as part of a program for which a grant has been approved pursuant to this section.

"(B) Departments and agencies of the United States are encouraged, to the extent consistent with efficient administration, to enter into arrangements with institutions of higher education for the full-time, part-time, or temporary employment, whether in the competitive or excepted service, of students enrolled in programs set forth in applications approved under subsection (a)

"AWARD OF SCHOLARSHIPS

"Sec. 18. (1) The Secretary is authorized to award scholarships in accordance with the provisions of this section for undergraduate study by persons who plan to enter an occupation involving the operation and maintenance of treatment works. Such scholarships shall be awarded for such periods as the Secretary may determine but not to exceed four academic years.

"(2) The Secretary shall allocate scholarships under this section among institutions of higher education with programs approved under the provisions of this section for the use of individuals accepted into such programs, in such manner and according to such plan as will insofar as practicable -

"(A) provide an equitable distribution of such scholarships throughout the United States; and

"(B) attract recent graduates of secondary schools to enter an occupation involving the operation and maintenance of treatment works.

"(3) The Secretary shall approve a program of an institution of higher education for the purposes of this section only upon application by the institution and only upon his finding -

"(A) that such program has as a principal objective the education and training of persons in the operation and maintenance of treatment works;

"(B) that such program is in effect and of high quality, or can be readily put into effect and may reasonably be expected to be of high quality;

"(C) that the application describes the relation of such program to any program, activity, research, or development set forth by the applicant in an application, if any, submitted pursuant to section 16 of this Act; and

"(D) that the application contains satisfactory assurances that (i) the institution will recommend to the Secretary for the award of scholarships under this section, for study in such program, only persons who have demonstrated to the satisfaction of the institution a serious intent, upon completing the program, to enter an occupation involving the operation and maintenance of treatment works, and (ii) the institution will make reasonable continuing efforts to encourage recipients of scholarships under this section, enrolled in such program, to enter occupations involving the operation and maintenance of treatment works upon completing the program.

"(4) (A) The Secretary shall pay to persons awarded scholarships under this section such stipends (including such allowances for subsistence and other expenses for such persons and their dependents) as he may determine to be consistent with prevailing practices under comparable federally supported programs.

"(B) The Secretary shall (in addition to the stipends paid to persons under subsection (a) pay to the institution of higher education at which such person is pursuing his course of study such amount as he may determine to be consistent with prevailing practices under comparable federally supported programs.

"(5) A person awarded a scholarship under the provisions of this section shall continue to receive the payments provided in this section only during such periods as the Secretary finds that he is maintaining satisfactory proficiency and devoting full time to study or research in the field in which such scholarship was awarded in an institution of higher education, and is not engaging in gainful employment other than employment approved by the Secretary by or pursuant to regulation.

"(6) The Secretary shall by regulation provide that any person awarded a scholarship under this section shall agree in writing to enter and remain in an occupation involving the design, operation, or maintenance of treatment works for such period after completion of his course of studies as the Secretary determines appropriate.

"DEFINITIONS AND AUTHORIZATIONS

"Sec. 19. (1) As used in sections 16 through 19 of this Act -

"(A) The term 'State' includes the District of Columbia, Puerto Rico, the Canal Zone, Guam, the Virgin Islands, American Samoa, and the Trust Territory of the Pacific Islands.

"(B) The term 'institution of higher education' means an educational institution described in the first sentence of section 1201 of the Higher Education Act of 1965 (other than an institution of any agency of the United States) which is accredited by a nationally recognized accrediting agency or association approved by the Secretary for this purpose. For purposes of this subsection, the Secretary shall publish a list of nationally recognized accrediting agencies or associations which he determines to be reliable authority as to the quality of training offered.

"(C) The term 'academic year' means an academic year or its equivalent, as determined by the Secretary.

"(2) The Secretary shall annually report his activities under sections 16 through 19 of this Act, including recommendations for needed revisions in the provisions thereof.

"(3) There are authorized to be appropriated $12,000,000 for the fiscal year ending June 30, 1970, $25,000,000 for the fiscal year ending June 30, 1971, and $25,000,000 for the fiscal year ending June 30, 1972, to carry out sections 16 through 19 of this Act (and planning and related activities in the initial fiscal year for such purpose). Funds appropriated for the fiscal year ending June 30, 1970, under authority of this subsection shall be available for obligation pursuant to the provisions of sections 16 through 19 of this Act during that year and the succeeding fiscal year.

CURRENT TRAINING ACTIVITIES
IN
WATER AND WASTEWATER TECHNOLOGY
AT
THE ATLANTA AREA TECHNICAL SCHOOL

Robert A. Ferguson
Director
Atlanta Area Technical School

It is indeed a privilege and honor to participate in this important conference dealing with a problem that is most pressing to our communities, our states, and the nation; and one that must be attacked with vigor if we are going to survive under the deluge of refuse and pollution that is being created by modern society. However, I have had great misgivings about what I could say to this group of professionals that would have significance and perhaps help with the problem. This is especially so when we consider Atlanta Area Technical School is probably the newest participant in this phase of education. I might have been wise to pass up this invitation and come back in a couple of years and tell you what we have learned. However, this would not be consistent with Atlanta Area Technical School, which attempts to be bold, attempts to be innovative, and attempts to meet the relevant needs of its students as well as the community. It has been said that what we lack in technical finesse, we make up in

ERIC

enthusiasm and willingness to do. So at best, perhaps I can offer you some enthusiasm this morning as we discuss together what we are doing in water and wastewater treatment training.

As I develop this paper with you this morning I would like to touch on several areas; one being a short review of our school -- its scope, content, purposes, and the people we serve. Then a quick review of the curriculum structure of the two-year sanitary engineering technology program, along with our short course activities. Then, share with you some of the trials and tribulations we have encountered in our short experience in this activity, and finally what we hope to do in the future.

The Atlanta Area Technical School was built as a joint endeavor between the Atlanta Public Schools System and the State Department of Vocational Education at a cost of nine million dollars. Five and one quarter million for the building and real estate, two and three quarters million for instructional equipment. The school is composed of two buildings; one with two hundred thirty-thousand square feet which houses all programs except the aviation program, which is housed in the other building of some seventy thousand square feet. Total operational floor space represents some seven football fields underroof. The school has no outside windows and is completely climatic controlled.

Since moving into the building in late December of 1967, we have grown rapidly. We now have 1600 full time students and 4600 evening school students; in addition, we are offering programs to better than 1000 students in plants throughout the metropolitan Atlanta Area. The school is open to any student 16 years of age and out of formal school, either by virtue of high school graduation or because he is dropped out for a variety of reasons. The school operates on a four-quarter, 12 month basis. Full time students only pay $21.00 per quarter registration fee. The only other expense would be for books. We offer training in 45 different occupational areas with an entrance requirement ranging from nothing to that which would be equivalent to most colleges. In addition, we have courses ranging in length from three weeks, two hours a day, up to two years, six hours per day. The school has an open door enrollment policy, which means that persons over 16 years of age desirous of gaining occupational competency may attend the School. However, the course he takes is based on whether he meets the course's entrance requirements. Prior to entering, the student will have taken a battery of guidance and placement tests and met with the guidance counselors. We find in the process of placement counseling that we have as many students under-shooting their potential as over-shooting it. Of course, the end point of all the testing and counseling is to place the student in a program

ERIC

in which he is interested, has the native ability for, and has a great potential for occupational success.

We now have a full-time faculty of 110 teachers, some 35 administrative and secretarial personnel, along with better than 300 part time instructors, who are primarily concerned with our evening school activities.

We have three phases in our operation: the full-time day school, the evening school and the in-plant services. The objective of the full-time day school is to bridge the gap between the student's formal education, be it a third grade education or a high school diploma, and an occupational job. Essentially these are young people with an average age of around 21-22 years of age, who are recent high school graduates, and who need to prepare for occupational pursuit. The evening school has as its objective the training of persons already employed but who are desirous of upgrading their skills and knowledge or enchancing their job security by keeping abreast with the new technology and innovations that are coming into the industrial and business scene. Our in-plant service has as its objective to work with business and industry in upgrading and retraining its personnel. It is in this activity that we go into industry and develop tailormade courses to meet their particular needs. It is through this division that we offer short courses for water and treatment plant operators, water chemists, and supervisory training.

We are prolific in the use of industry advisory committees. As a matter of fact we have an individual committee for each area we train. These advisory committees meet no less than two times a year and considerably more often in a new, developing program. In our opinion these advisory committees are a must. Through their help we can keep our programs in tune with the needs of industry, see that the theory, technique, and equipment is consistent with the needs and practices of industry, plus utilizing their assistance in recruiting and placement of students. Of course, another important part of the advisory committee's responsibilities is to help us identify and jointly develop short courses which would be of value to those already employed in the field.

So much for the school. Let us now turn our attention to our sanitary engineering technology program. The program is a two-year course, consisting of 8 quarters of 336 hours per quarter, for a total of 2688 clock hours of training. Students must be a high school graduate or equivalent and have a desire to work in the field of sanitary engineering technology. Our curriculum is essentially that curriculum which was developed by Charles Purcell of Fayetteville, North Carolina, for the U. S. Office of Education, and now being conducted in the Fayetteville Technical School. Without boring you with the details of the curriculum itself, which will be printed in the conference report, let me only touch on the highlights of what it includes. I suppose one could say it is broken up into four major areas of doing and knowing. One area would be what I consider the construction phase. This would deal with the basic and advanced surveying, construction principles and practices as it applies to water and wastewater lines, plant construction with heavy emphasis on drafting techniques. Another phase would be considered the operational phase. In this part of the curriculum, attention is given to how water or wastewater plants function, water hydraulics, electrical and electronic apparatus, the maintenance activities, coupled with the governmental regulations and plant safety associated with plant operations. Another phase of the curriculum would have to do with the chemical and microbiology aspects of water and wastewater treatment. Emphasis would be on the variety of standard tests which must be performed. The last phase would be the related knowledge which would incorporate the math, communication skills, physics and technical report writing. Of course, sprinkled throughout the curriculum would be those things having to do with human relations, work habits, along with activities that would develop a pride for the field of sanitary engineering technology. By and large, the advisory committee feels that we have a solid curriculum and a curriculum which would develop a technician capable of making a contribution. He would not be an operator nor an engineer upon graduation. He will be an advanced trainee with the potential to develop rapidly into a valuable employee, either in an operational activity or in a design engineering environment. At the most we hope that he will upon graduation be a profitable employee. The thrust of his training has been in the doing activities supported by a solid base of technical understanding. As a matter of fact, all of our programs at Atlanta Area Technical School are structured to develop a practical performing person as opposed to a technically smart person who cannot do anything. By policy we attempt to implement the curriculum wherein 60% of it will be practical application and 40% theory. When onereviews our curriculum it would appear about the same as most associate degree programs now being offered by many community colleges. The big difference, however, is our emphasis on the application as opposed to theory. Now that we have reviewed the general outline of our course of study in sanitary engineering technology, let us talk about students.

First off, the number one problem is student recruitment; not a unique problem, however, as it is seemingly commonplace. We started last September with our first class in sanitary engineering technology. This start was premature as we had not planned to start until this fall as we had not completed the hydraulics lab, nor did we have a sanitary engineering teacher on board. However, when seven signed up to take the program, it did not take us long to get in business. You may wonder how we could do this without a teacher. This was not difficult because we have a companion program in Civil Engineering Technology, a Chemical Technology and an Electrical Technology program, all staffed and well equipped. Many of the base courses in these programs are similar. During the year we have lost two of the seven students. However, our enthusiasm has not decreased on the same ratio. As a matter of fact, we are more enthusiastic today than ever before about our program. We visualize great things happening as we organize our activities of recruitment. One of the two students who left the program joined the Navy and the other transferred to Carroll County Technical School. Of the five remaining, two are employed full time in wastewater treatment plants. They range in age from 23 to 37 years. All of them have received job offers. As a matter of fact, we had a president from a design engineering firm who made them a firm offer of $7200.00 a year. In fact, he would take all of them upon graduation. Of course, finding jobs for these graduates is not the problem. The number one problem is the recruiting of students. Sanitary engineering technology is not the most attractive title as it gets tied up with mothers and fathers, boys and girls' mental image of what the sanitary engineer technician does. As you are all aware, they have the mental image of Art Carney and the sewer hole. However, I believe that we are rapidly approaching the day when this distinction will fade out and we must develop some other types of titles that perhaps would be more prestigious and more in vogue with our current society's value concepts, so that we will be able to merchandise this program. In light of the current and seemingly expanding national advertising campaign, we are proposing to change the name of our course from Sanitary Engineering Technology to Pollution Control Technology. We feel that this will help; even though it is euphemistic it will be something that we can talk about to mothers and fathers, boys and girls who may have an understanding of its tremendous importance as a community service. It may well take on the same dimension that our health occupations training does. It appeals to those individuals who desire to make a contribution to their fellow men. Another important and exciting program we feel is going to help us in the recruiting line is our plan to bring high school seniors into the Atlanta Area Technical School on a full time basis to pursue the course in Pollution Control Technology. Essentially this will be open to high school seniors who have completed all the requirements for graduation except the four electives which are normally taken in the senior year. That is, they are just grinding out time with no particular requirements other than being there. To enhance this program we also will offer them a scholarship for the first year. They would be carried on the roll in the high school and would participate in their high school functions. By the time they graduate in June they will have already gained about one year of training in water and wastewater treatment. Another aspect of our recruiting activities that we are gearing up for at the present time is an appeal to returning veterans to become a pollution fighter. This will require an aggressive newspaper and perhaps radio campaign. Money will pose a problem but maybe we can get some help from some of your agencies or companies. To compliment this recruiting effort we must revise our thinking on when students may start. Traditionally, we have only accepted students each fall. We see now that this is not feasible at all. First, the mechandising program must be a year-around activity. If we can cause someone to get excited and want to enter in training, perhaps in November, after school has been underway for two months and then we tell him to come back next September, ten months later, we are only kidding ourselves. Another side of this problem is the normal loss which occurs during the year. Under the usual once-a-year enrollment plan, there is no way to add students after you are underway. In other words we have a lockstep schedule. This problem exists in all of our programs and was of such concern to us and the State Department of Vocational Education that an industrial management engineer was employed to attack the problem. The reason why an industrial management engineer was hired was because he is a specialist in production scheduling and this, in our opinion, is a scheduling problem. Of perhaps even more importance, he was not a school man steeped in educational tradition. After a great deal of soul searching and head knocking we have restructured our schedule around what we call flexible scheduling. Without going into the details let me just say we now can enter new students at any quarter, joining our old students but under no circumstances do they have to miss any part of the curriculum. In fact the whole concept is built around prerequisite trees. I will not try to explain the mechanics at this time, but invite you to visit us if you care to look into the matter. We now feel we can end the school year with as many students as we started. For certain not the same students but still a decent student/teacher ratio. A by-product of this work was our realization that we could easily tailormake a course of study for almost anyone who wants to go to school, either for a unique length of time or for a unique body of knowledge. When we lined up all of our various courses of studies and identified all the courses that do not require prerequisites, we readily saw where we could design a meaningful course of study at the beginning of each quarter.

Perhaps a person only wants training in one area. Under this arrangement we probably could enter him any time. Say an operator was needing to bone up on his microbiology in preparation for certification. He could, providing his

ERIC

work hours were right, come over and take only those courses. Well, to say the least we are excited about this scheduling technique.

So much for our full-time program. For certain it is not enough to train the new blood; we must upgrade the present blood. In the manner we are organized we can conduct programs during the day, the evening or on the weekends, either in the school or in the plants. About a year ago we conducted one of the five three-week waste water technology pilot programs under a grant from FWPCA. The program was designed exclusively for operators with three to five years experience who possessed a high school diploma. The objective was to enhance their technical capabilities. A secondary objective was to establish within these students the worth of advanced education. It was thought they would go back to their plants and encourage their co-workers to participate in short courses and advanced training activities. The course of study included water sources, uses, pollution sources, prevention methods and water standards, types of treatment, chemistry and microbiology, hydraulics and other supporting relative topics. The instructors were selected from industry upon the recommendation of the advisory committee. Student recruiting was done by the regional office of FWPCA. The plan was to take twenty trainees, but because of the great interest twenty five were accepted from five states in this region. All instruction was designed and planned for the operator with three to five years experience and a high school diploma. After surveying the class on the first day we learned that all of our months of planning went down the drain. We had non-readers, up to the college readers. We had people with math capabilities, ranging from 4th grade to calculus; we had job classifications from operators to superintendents. The biggest majority of students were in supervisory positions. This group had responsibility for 60 plants with a combined plant capacity of 407 million gallons per day. Needless to say, the instructors had extreme difficulty in reorganizing materials and presenting their topics in a manner which would be profitable to this wide, diverse group of students.

In the area of mathematics, we separated them into various levels but this did not prove satisfactory as the group wanted to participate together. We regrouped them and proceeded on the premise that it would be a review for the engineer, an informative lesson to the mid group, and an overview of the needed math capabilities for the low performer. To put it frankly, in many areas of the program it was a complete "snow job" for some, a boring review for some, and for a few a practical presentation which had application for their current job activities. Perhaps I am sounding too critical of a program which, in the end, proved to be most successful. The thing which was really troublesome was that we practically had to design the course

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each evening for the next day. However, with all the difficulties encountered, we did send the fellows home with not only a feeling of success but equipped with new knowledges that prepared them to better perform in their respective jobs. For certain it was felt they will become recruiters, for others to participate in advanced educational activities. Through our in-plant division we now have underway a course in atomic absorption spectroscopy designed primarily for technicians or laboratory workers in the water and pollution control laboratories in the greater metropolitan area. The course will enhance the student's knowledge and skills in this particular analytical technique.

Another short course activity we are involved in at the present moment is a joint program involving the Georgia Water Quality Control Board, Manpower Division of the State Department of Vocational Education, and the plants in the greater metropolitan area. We are carrying out the educational part of the program which includes two full weeks plus one-half day for ten weeks of training in the school dealing primarily with math, reading improvement, chemistry and microbiology and theory of water treatment. This, coupled with 26 weeks of on-the-job training under a training coordinator who attempts to see that they have a variety of work experiences which would develop an all-around operator, and one who could perform at a higher licensing requirement. We are experiencing some of the same difficulties we experienced in our first short course that addresses itself to lack of homogenity among the students. Again, we have a very wide, diverse group of people -- non-readers, third graders, to college people, from laborers to class "B" operators. At least they all have a common desire to improve themselves. However, we are now convinced that we will never be able to get a homogenous grouping in our short course activities. It would be nice to have, easy to handle, but probably unpractical and unrealistic as we intensify our training activities for industry personnel. It is for us, the vocational educator, to redesign our approach so we can meet the relevant needs of the people as they come to us, rather than design a program for a certain type and accept only those who fit our mold. We must develop and use more programmed learning materials, more individualized teaching, and for certain get back to the little red school house approach to education. There we dealt with the students as they came to us. Everyone participated at the table of education.

In closing, we look forward to doing a lot of things in water and pollution control technology. We must constantly address ourselves to the job of changing the image of this particular occupational activity into its true importance, an occupation with dignity in the eyes of the general public. This can be done in part by changing the titles into something that is perhaps more glamorous, even though it is outright practice of euphemism. Even more fundamental, and I address this charge to those people in positions of responsibility in the industry, and it would be to seriously and positively work to improve pay scales for the operators and technicians. It is of little value to tell someone how important his contribution is to society, how important it is for him to advance his education, how great the future is for his promotion to other job opportunities, when the pay is in many respects pitiful in its comparison with other occupational jobs which pay a great deal more and are of considerable less importance. It is of little wonder that we have such a tragic situation in terms of types and kinds of people who we have been able to recruit into this activity. Another thing we would very much like to do is to start a co-op program in technician training whereby students could train a quarter and work a quarter with an advancing salary as they learn. We have this with the state highway department, with the air conditioning and refrigeration industry, and others are getting underway. It is a cheap investment that could and would provide a steady flow of trained technicians into the pollution control agencies. So far as the municipal plants go, unless there is some drastic change, the engineering companies will drain off all the talent that we in vocational-technical education and other sub-professional training activities will turn out. They are either more sensitive or find it easier to compete in the job market than the governmental agencies. I am personally still amazed and in a state of wonderment as to how the great state of Georgia can operate its vast water and wastewater plants with only 15 class A operators. Recently, one of the students in one of our short courses told me that about all they were able to do is to take out the big chunks. We hope that with our combined efforts and perhaps resulting from this short course, we can mobilize better those resources that will help to move positively and quickly work towards the ending of this dire shortage of trained personnel in the field of pollution control. It is to this end that we are dedicating our activities at Atlanta Area Technical School.

APPENDIX A

SANITARY ENGINEERING TECHNOLOGY

Length of Course: Two Years

The Sanitary Engineering Technology curriculum will include studies in microbiology, sanitary chemistry, water supply, purification and distribution, sewerage systems, water pollution control, liquid and solid waste treatment, and supporting courses in basic science, mathematics and related courses.

CURRICULUM

FIRST YEAR

1st Quarter	Hours
Technical Drafting, SAE-202	56
Communication Skills I, REL-105	56
Technical Math I, REL-101*	56
Basic Chemistry, REL-104*	56
Introduction to Sanitation, SAE-201	112
	336

2nd Quarter	Hours
Technical Report Writing, REL-111*	56
Technical Drafting, SAE-206	112
Technical Math II, REL-112*	56
Applied Biology, SAE-203	112
	336

3rd Quarter	Hours
Applied Sanitary Math, SAE-211	56
Basic Hydraulics, SAE-216	112
Elementary Surveying, SAE-205	112
Physics—Properties of Matter, CIV-229	56
	336

4th Quarter	Hours
Hydraulics, SAE-221	112
Microbiology, SAE-204	56
Applied Electricity, SAE-214	56
Economics, REL-107*	28
Human Relations, REL-108*	28
Physics—Work, Energy, Power, CIV-208	56
	336

SECOND YEAR

5th Quarter	Hours
Advanced Hydraulics, SAE-213	56
Water Supply & Liquid Waste, SAE-207	56
Water Purification, SAE-210	112
Sanitary Chemistry & Biology, SAE-208	112
	336

6th Quarter	Hours
Codes, Contracts & Specifications, SAE-229	56
Liquid Waste Treatment I, SAE-209	112
Industrial Electronics, SAE-230	56
Sanitary Chemistry & Biology II, SAE-212	112
	336

7th Quarter	Hours
Control Systems, SAE-219	112
Liquid Waste Treatment II, SAE-218	112
Sanitary Chemistry & Biology III, SAE-217	112
	336

8th Quarter	Hours
Engineering Surveying, SAE-220	112
Special Problems in Water & Waste Water Treatment, SAE-215	112
Sanitary Chemistry & Biology IV, SAE-231	112
	336

*Denotes related course.

Curriculum subject to revision to meet changing conditions.

APPENDIX B

COURSE DESCRIPTIONS

INTRODUCTION TO SANITATION, SAE-201

This course includes methods of disease transmission, hygienic excreta disposal, municipal and industrial liquid waste disposal methods, characteristics of water, water treatment, protection of ground water, insect and rodent control, solid waste collection and disposal, milk and food sanitation, swimming pool sanitation and industrial hygiene.

TECHNICAL DRAFTING I, SAE-202

The field of drafting is introduced as the student begins study of drawing principles and practices for print reading and describing objects in the graphic language. Basic skills and techniques of drafting included are: use of drafting equipment, lettering freehand, orthographic and pictorial sketching, geometric construction, orthographic instrument drawing of principle views, and standards and practices of dimensioning. The principles of isometric, oblique and perspective are introduced.

APPLIED BIOLOGY, SAE-203

This is a basic course in biology with emphasis on microorganisms and laboratory procedures for the identification and differentation of organisms peculiar to the water and liquid waste treatment processes and stream sanitation.

MICROBIOLOGY, SAE-204

Scope and history of microbiology, classification of microorganisms, protozoa, fungi, viruses; microscopy, bacterial physiology, saprophytic bacteria, culture media and methods, sterilization and disinfection, germicides, sources of infection, microbes and disease, skin infections. The study of several pathogenic bacteria associated with water and food, natural and acquired resistance to bacteria, and respiratory disease-producing microbes.

ELEMENTARY SURVEYING, SAE-205

Theory and practice of plane surveying, including taping, differential and profile leveling, cross sections, earthwork computations, transit, stadia, and transit-tape surveys.

TECHNICAL DRAFTING II, SAE-206

The application of orthographic projection principles to the more complex drafting problems, primary and secondary auxiliary views, simple and successive revolutions, and sections and conventions will be studied. Most important is the introduction of the graphical analysis of space problems. Problems of practical design elements involving points, lines, planes, and a combination of these elements shall be studied. Dimensioning practices for "details" and "working drawings," approved by the American Standards Association will also be included. Introduction is given to intersections and developments of various types of geometrical objects.

WATER SUPPLY AND LIQUID WASTE, SAE-207

Water sources, quantity required, effect of storage on quality, quantity of storage, transportation, protection from pollution, methods of evaluating water quality, the ability of a water course to assimilate waste, stream sampling procedure and distribution design, are integral parts of this course.

SANITARY CHEMISTRY AND BIOLOGY I, SAE-208

Theory and laboratory techniques for all control tests of water purification including: bacteriology, color, turbidity, pH, alkalinity, hardness, coagulation, chlorides, fluorides, iron, manganese, detergents, bactericides, and nitrates. Basic in-plant studies at nearby plants.

LIQUID WASTE TREATMENT I, SAE-209

This course will include composition of sewage, nitrogen cycle, carbon cycle, sulphur cycle, aerobic and anaerobic decomposition, dilution, screening, degritting, measuring, sedimentation, aeration, digestion, filtration, air drying, biological purification, grease and oil removal, disinfection, chemical precipitation, sand filters, filter flies, field studies, in-plant studies, industrial waste. Rules, regulations, forms and records.

WATER PURIFICATION, SAE-210

Water purification is concerned with basic principles including: aeration, sedimentation, rapid sand filtration, chlorination, treatment chemicals, taste and odor control, bacteriological control, mineral control, design criteria and operational problems. New processes and recent development will be discussed. Rules, regulations, forms and records.

APPLIED MATH, SAE-211

The fundamental concepts of analytical geometry, differential and integral calculus are introduced. Topics included are graphing techniques, geometric and algebraic interpretation of the derivative, differentials, rate of change, the integral and basic integration techniques. Applications of these concepts to practical situations are stressed.

SANITARY CHEMISTRY AND BIOLOGY II, SAE-212

Theory and laboratory technique for the determination of solids, dissolved oxygen, oxygen consumed, relative stability, water and sewage bacteria.

ADVANCED HYDRAULICS, SAE-213

An advanced applications course that teaches students how to make everyday applications of techniques and knowledge gained in previous courses. Extensive laboratory work constitutes the major effort for the students.

APPLIED ELECTRICITY, SAE-214

Electrical code, interpretation of nameplate data motor characteristics and selection, motor controls and protection devices, single-phase and three-phase current applications, wire size calculations and Wye and Delta connections.

SPECIAL PROBLEMS IN WATER AND WASTE WATER TREATMENT, SAE-215

A complete review of the sanitary engineering course. Special field design and operations problems will be covered under job simulated conditions in order to gain final employment readiness.

BASIC HYDRAULICS, SAE-216

A basic study of closed conduit and open channel flow, including stream flow, subterranean flow, runoff, pump head and wave action. The basic classroom study is supplemented with extensive laboratory experiments and projects.

SANITARY CHEMISTRY AND BIOLOGY III, SAE-217

This course includes theory and laboratory technique on biochemical oxygen demand, organic nitrogen, volatile acids, toxic metals, stream studies, in-plant studies at nearby plants.

LIQUID WASTE TREATMENT II, SAE-218

Methods of treatment, detailed study of at least two types of plants, basic design parameters of all units, quantity expected from population, application of package plants and application of septic tanks are covered in this course. Rules, regulations, forms and records are introduced.

CONTROL SYSTEMS, SAE-219

Hydraulic, pneumatic, mechanical, electrical and electronic control systems and components. Basic description, analysis and explanation of operation of control systems. Typical performance characteristics, limitation on performance, accuracy, applications and their utilization in industrial processes.

ENGINEERING SURVEYING, SAE-220

Route surveys for ground methods: simple and parabolic curves; relation of the cross sectional and profile: earthwork computations; calculations of areas of land by DMD. Method and areas of miscellaneous shapes of land; building and pipeline staking.

HYDRAULICS, SAE-221

Continuation of Basic Hydraulics, introduction to intensity of pressure, result of pressure on immersed plane surface, center of pressure on gates and vans, pressure on curved surfaces, distorted orifices, tubes and weirs, study of flow to orifices, nozzles and tubes, loss of head and orifice, nozzles and tubes. Charge of weirs, discharge of falling head, flow-through pipes. Related lab practices add to importance of hydraulics to water and waste water laboratory.

PHYSICS II, SAE-227

Major areas covered in this course are work, energy, and power. Instruction includes such topics as statics, forces, center of gravity, and dynamics. Units of measurement and their applications are a vital part of this course. A practical approach is used in teaching students the use of essential mathematical formulas.

CODES, CONTRACTS, SPECIFICATIONS AND ESTIMATES, SAE-229

This course is a study of the basic principles and methods most significant in contract relationships including appreciation of the legal considerations in construction work: study of the National Building Code and local building codes; interpreting and outlining specifications.

INDUSTRIAL ELECTRONICS, SAE-230

A study followed with lab applications of the electronics devices used in plant instrumentations. Lever controls, sensing units, recorders, will be studied as it applies to plant design and maintenance.

SANITARY CHEMISTRY AND BIOLOGY IV, SAE-231

A final theory and laboratory review of chemistry and biology. Emphasis will be on simplified standard laboratory practices and procedures.

APPENDIX C

Atlanta Area Technical School
Wastewater Technology Short Course

DAILY SCHEDULE

October 7-11, 1968

Time	Period	Monday Oct. 7	Tuesday Oct. 8	Wednesday Oct. 9	Thursday Oct. 10	Friday Oct. 11
8:00 --- ---	1	Opening activity*	Hydraulics Robert Wilroy Jerry Butler	Hydraulics Robert Wilroy Jerry Butler	Hydraulics Robert Wilroy Jerry Butler	Hydraulics Robert Wilroy Jerry Butler
9:00 --- ---	2	Water Sources Rod Davis	" "	" "	" "	" "
10:00 --- ---	3	Pollution Sources Robert Roth	Safety Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell
11:00 --- ---	4	Water Uses Robert Roth	Community Relations Staff	" "	" "	" "
12:00 --- ---	5	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:00 --- ---	6	Mathematics Gordon Taylor Hillary Hurt	Mathematics Gordon Taylor Hillary Hurt	Mathematics Gordon Taylor Hillary Hurt	Mathematics Gordon Taylor Hillary Hurt	Mathematics Gordon Taylor Hillary Hurt
2:00 --- ---	7	Water Quality Standards Howard Zeller	Chemistry Virlyn Florence	Chemistry Virlyn Florence	Chemistry Virlyn Florence	Chemistry Virlyn Florence
3:00 --- ---	8	Pollution Prevention J. C. Meredith	Buzz Session	" "	" "	" "

*Welcome: John F. Standridge, Executive Director
Vocational-Technical & Adult Education
Atlanta-Fulton County Public Schools

Robert A. Ferguson, Director
Atlanta Area Technical School

Opening Remarks: John R. Thoman, Director
Southeast Region F.W.P.C.A.

Charles A. Purcell, Jr., P. E.
Short Course Coordinator
Fayetteville, North Carolina

Atlanta Area Technical School
Wastewater Technology Short Course

DAILY SCHEDULE

October 14-18, 1968

Time	Period	Monday Oct. 14	Tuesday Oct. 15	Wednesday Oct. 16	Thursday Oct. 17	Friday Oct. 18
8:00	1	Chemistry Virlyn Florence	Biology Virlyn Florence	Hydraulics Robert Wilroy Jerry Butler	Biology Virlyn Florence	Human Relations Harry Malone
9:00	2	" "	Human Relations Harry Malone	" "	" "	" "
10:00	3	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell
11:00	4	" "	" "	" "	" "	" "
12:00	5	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:00	6	Field Trip Charles Purcell Jerry Butler	Mathematics Gordon Taylor Hillary Hurt	Mathematics Gordon Taylor Hillary Hurt	Hydraulics Field Trip Robert Wilroy Jerry Butler	Mathematics Gordon Taylor Hillary Hurt
2:00	7	" "	Preventive Maintenance Stan Weill	Biology Virlyn Florence	" "	Biology Virlyn Florence
3:00	8	" "	" "	" "	" "	" "

Atlanta Area Technical School
Wastewater Technology Short Course

DAILY SCHEDULE

October 21-25, 1968

Time	Period	Monday Oct. 21	Tuesday Oct. 22	Wednesday Oct. 23	Thursday Oct. 24	Friday Oct. 25
8:00	1	Sampling Gene Holcome	Instrumentation Staff	Instrumentation Staff	Instrumentation Staff	Instrumentation Staff
9:00	2	" "	" "	" "	" "	" "
10:00	3	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell	Types of Treatment Charles Purcell
11:00	4	" "	" "	" "	" "	" "
12:00	5	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:00	6	Instrumentation Staff	Field Trip Charles Purcell Jerry Butler	Preventative Maintenance Staff	Organizational Relationship Barney Conger	Records & Reports Bob DeLoach
2:00	7	Biology Virlyn Florence	" "	Safety Glen Huber	" "	" "
3:00	8	" "	" "	" "	" "	Closing Activities

CURRENT INDUSTRY ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

Gerald M. Corbett
The Dow Chemical Company
Midland, Michigan

INTRODUCTION

The ability to continue to improve productivity is extremely necessary in our competitive industrial world. Training and education, carefully used, are one of the means of achieving these productivity gains. The properly trained employee is likely to get more satisfaction from his job and also to be a more productive person. A well-designed program of education and training, based on sound economics, and aimed at the real needs of the company, is an important part of overall planning and activity.

Industry can hire professional men with sufficient training to enable them to handle their job assignments. If additional training becomes necessary, graduate programs are usually available, and frequently at company expense. It is in the areas of craftsmen and technicians that industry really feels the pinch; for these people are not professionally trained and they need considerable training to do their jobs. Even unskilled labor today faces demands requiring some sort of training.

PHILOSOPHY OF TRAINING

Of the several methods used to increase individual effectiveness, probably no single one is as important as on-the-job training. The Dow Chemical Company has been conducting on-the-job training programs for more than forty years. Today these training programs involve every employee, from management and supervisory personnel down through all areas of maintenance and production. The value of a joint employer-employee training program can not be overestimated.

Since education and training is a service function, it can not be effective unless it meets the real needs of the people involved. The major task is not to teach something, but to motivate people to want to learn. Knowledge doesn't necessarily mean skills; one should concentrate on job performance rather than knowledge. The first and foremost consideration of any training program is to identify the overall needs of the program. The following guidelines are useful considerations in conducting a "needs analysis"?

1. What do you want the man to do?
2. Why isn't he doing it now?
3. What happens if he does the job wrong?
4. What happens if he does the job correct?
5. Is it a can-do or won't-do situation?
6. Maybe you don't need training.

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OPERATOR TRAINING PROGRAM

It is the primary purpose of this paper to discuss on-the-job training programs for operators and technicians. At this point let us consider training programs for production operators. Training the people who operate production equipment has always been an important supervisory responsibility.

The processes themselves have continued to grow more complex and the controls more sophisticated, while the fundamental knowledge operators bring to the job has remained almost constant over the years. To compound the problem, competition for the supervisor's time has grown more and more intense.

Our solution to this problem has been a training program which proceeds from the general basic fundamentals to the specific in three stages:

1. A GENERAL COURSE - it includes the study of basic plant equipment, operating problems, general practices, as well as a review of practical arithmetic.
2. SPECIAL COURSES - for each production plant. These cover the raw materials, the process itself, and the products of the individual plant.
3. IN-DEPTH COURSES - covering the technology of the various segments of a process.

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The training is especially tailored to fit the job requirements for each situation. Instruction techniques involve a multi-media approach when possible. Among these are the classroom instruction, coaching, programmed learning, visual aids, and manipulative instruction.

Supervisors are involved as closely as possible in the complete training program. This is particularly valuable in the preparation of text materials for the special and in-depth courses. Supervisors are also involved in the actual instruction and in coaching where possible. A positive relationship is thus maintained between the department supervisor and the employee as they work together for their mutual benefit.

It is virtually impossible to purchase books which can serve as good texts for operator training. The text materials used must be written with a low *Fog Index*, and must not be ambiguous. We think it should be written by people who have first-hand knowledge of industrial operations. It is essential that data be augmented by good illustrations, examples, and photographs as much as possible.

RESEARCH TECHNICIAN TRAINING PROGRAM

Like production operators, technicians need to continue improving their skills to learn new techniques to keep pace with improvements in technology. To help provide such

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training, we have established a broad range of programs for people in these job areas.

Our formal training program is divided into two parts, or courses. The first course is academic in nature, involving the more practical aspects of chemistry, physics, and mathematics. The second course is concerned with the aspects of process equipment, process operations, and instrumentation.

For our more highly skilled technicians, we prepare *Study Guide Manuals* covering the aspects of chemistry, physics, and mathematics we expect our people to be knowledgeable about. These study guides cover increasing degrees of proficiency in the sciences from high school up to and including the second year college level. Training is administered by a multi-media approach such as self-study, and programmed learning. Advancement is by written examinations conducted quarterly.

EVALUATION OF TRAINING PROGRAMS

It is very difficult to properly evaluate any training program. The four methods most commonly used are as follows:

1. Written examinations.
2. Discussion with supervisors.
3. Apparent improvement in personnel motivation.
4. JOB PERFORMANCE.

Grades have little value unless examinations are very carefully prepared and administered. Grade getting is in itself a special skill, which consists of learning to get along with the system.

The real criterion of training effectiveness is job performance. This may or may not be immediately apparent, but often manifests itself in the form of motivation and/or attitude improvement. Routine jobs are not routine when the operator is trained to be more than an appendage to the operation.

Jobs have little meaning as long as they are permitted to be nothing more than "doing a function". Work is meaningful only if it includes such factors as recognition, responsibility, achievement and growth. We believe the trained employee is in a much better position to use and understand the factors which help put meaning into the job. Thus, the trained employee is a better employee because he finds more job satisfaction.

WATER POLLUTION CONTROL FEDERATION ACTIVITIES IN WASTEWATER TREATMENT PLANT OPERATOR TRAINING

Sam L. Warrington
Texas State Department of Health
Austin, Texas

INTRODUCTION

Since its inception forty-two years ago, the Federation has been dedicated to water pollution control. At least half of its stated objectives in the constitution concern the manpower required to operate and maintain the complex facilities necessary for treating wastewater. This nation's most important resources are not wealth and machines, but they are human resources. Equipment, capital, and methods are important, but man is the vital heart that makes the system work.

The Federation has since 1941 had a committee concerned with operator certification and training. The charge to the committee was to "establish minimal qualifications for operators of various classes of treatment works. The committee also has the duty of collecting and compiling data on and developing programs for the licensing or certification and training of operators, including salary surveys."

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The Manpower Needs Committee was created by the Board of Control on October 12, 1967, and charged with surveying total water pollution control manpower needs, projecting future needs, and maintaining and updating the data not less than biennially. This committee was combined with the Personnel Advancement Committee at the 1969 WPCF meeting and the work will continue as a sub-committee. From its beginning, this committee has gathered information from the various states on these programs. Abbreviated reports on the status of operator training and certification have been published annually in the JOURNAL in the past decade.

"The Water Pollution Control Federation has been trying for many years to reduce one source of pollution - inefficient operation of wastewater treatment plants - by improving the know-how of the operators of these plants."

The key phases here are - "to reduce a source of pollution," and, "by improving operator know-how."

Efficient treatment - whether it be water or wastewater - must combine:

a. Proven and adequately designed processes.

b. Good and properly sized equipment.

c. Knowledgeable supervision and interested management.

d. Well trained operators.

For many years, the Committee has developed training aids, promoted certification of operators, and, in general, promoted the advancement of operators. The problem of manpower in wastewater works is currently drawing national attention from many directions. Questions are being asked in much greater depth than in former years. Some questions requiring attention are (1) what actually is an operator and what does he do? (2) what occupations are included in plant operations? (3) how can a high school graduate become a wastewater treatment plant operator? (4) where can he get post-high school training to equip him for a job in a wastewater treatment plant? (5) what are prospects for his employment? (6) who can he see about employment? (7) what can be expected in the way of a salary? (8) what are the prospects for future advancement in this type employment?

Some of these questions will be studied by the Committee on Personnel Advancement. This Committee will study in depth the problem of specifically defining tasks to be performed in wastewater operations and defining more specifically the jobs for purposes of job classification. Study of the problems of providing more detail in the occupations included in wastewater operations should be accompanied by some consideration of the remuneration of employees in these occupations.

New specialty courses will be prepared after completion of the Laboratory Training Course. These courses include: Mathematics for operators, basic chemistry for the beginning operator, treatment of industrial wastes in municipal treatment plants, safety in wastewater operations.

Although it may not appear the prerogative of this Committee to consider the question of treatment plant efficiency, it does appear desirable that consideration be given to specialty training of professionals who will be needed to evaluate the effectiveness and efficiency of wastewater treatment plant operations in terms of getting the most out of a specific physical facility. The Federation assembled an ad hoc committee to provide a special consultation with the Federal Water Pollution Control Administration in May 1968. This group considered the question of how to close the operations gap. It was pointed out by FWPCA personnel that among other gaps such as the criteria gap and the design gap, which limit the effectiveness of utilizing physical facilities to improve wastewater quality and control polution, the operator gap creates the greatest limitation on utilizing our present physical plants to control pollution. The operator gap is created by limitations on operator capabilities. These limitations can be overcome, in large part, by operator training. On the other hand, skilled operators can be guided in improving the effluent from a given physical plant by experts who can adjust processes and design operating regimen to meet variations in influent and maintain a high quality effluent. At present, there are few of these experts in the United States.

Regulatory agencies have in the past provided a varying amount of direct supervision over plant operations. Plant inspections have frequently been made, but in many cases only in operations emergencies. Operating reports are required by many regulatory agencies and a varying amount of review and evaluation of these is made. The Federation will look further into the manpower need in this plant evaluation and its role in complementing the operator improvement program.

Leadership and continuing support of mandatory certification by the Federation, through its model law and regulations and related information, has aided several states in the adoption of programs involving mandatory certification of operators. The WPCF staff continues to furnish information to persons studying and proposing legislation throughout the nation. During 1969, six states adopted mandatory certification requirements for wastewater operators. These are California, Connecticut, Georgia, Maine, and the two Carolinas. Voluntary programs were initiated by Hawaii and Nevada. This brings the count, as of September first, to twenty-three states with mandatory programs, and twenty-four with voluntary.

The strong and active support and encouragement of sound certification programs by the Federation has been most helpful in this overall effort.

Members of the Committee worked on the planning of the National Conference on Operator Training as approved by the Federation Board of Control in 1968. Although planning was undertaken with vigor during the winter and early spring, uncertainty of financing aspects made it expedient to substitute a one-day workshop with limited attendance for the larger three-day conference originally conceived, and to reduce expense and add convenience by holding it at Dallas immediately preceding the Annual Conference of the Federation.

A special three-member task force developed new survey questionaires for the annual survey of the programs of the Member Associations and states for operator training and certification. They have shared the task of analyzing the data received and the Chairman submitted a report at the workshop on Operator Training in Dallas. The report is now being prepared for publication in the Journal of WPCF.

The operator training grant program utilizing funds from Water and Wastewater Equipment Manufacturers Association has continued to be active. The Federation staff handled all applications and awards following guidelines developed by this Committee. To date, 150 grants totaling $15,000, have been awarded. Forty-five of these were awarded in 1969. If the 1968 experience is any indication of what will happen in 1969, we should end this year with a 2-year total of 250 operator grantees receiving about $25,000. The WWEMA is to be commended for the support of this worthwhile program.

Operator training aids in safety matters have been produced during the year. Two slide-illustrated lectures for safety training were prepared by the Federation staff with technical guidance by the Safety Committee. Additional lectures are being planned. These materials will supplement the Safety Program Promotional Packet developed by the Safety Committee.

The Committee has throughout its existance promoted Operator Certification. The WPCF policy, largely due to the efforts of the Committee, has changed from that of urging certification on a voluntary basis to stating that "mandatory certification or licensing of adequately trained and properly compensated personnel must be encouraged as a requirement for maximum effectiveness of treatment facilities." Recent efforts of the Committee have emphasized training, and training aids have been, and are continuing to be, produced to encourage improvements and uniformity in operator training. Wastewater treatment plant operator training course #1 with visual aids was introduced in 1966. Over 600 sets of slides and thousands of copies of the manuals have been sold. Wastewater plant operator training course #2 was released in 1967 and over 300 sets of slides have been sold. Both the course outlines and the slide sets are sold for the cost of duplication, printing, packaging and mailing. Only one other source of similar aids being sold at cost is known. The New York State Department of Health, Albany, New York, distributes 345 slides on analysis of wastewater samples.

The safety program promotional packet was developed by the Federation safety committee and will prove to be a promotional packet as well as a training packet for wastewater personnel. A promotional packet and a set of 66 slides are available again at cost from the Federation office.

Each month the Journal features "operator training opportunities" which lists schools and courses being offered. A survey made during 1967 under the Committee's Guidance pointed out that mandatory certification is acceptable to municipal management on the basis that it assures training accomplishment. Experience has shown that operator training has been improved after initiation of mandatory certification but in some cases inadequacies of training have delayed the initiation of mandatory programs. The Committee's program is based on a belief that training is a must and is the foundation of certification of operators. The conclusion of the survey made by Public Administration Service of Chicago for the Federation is as follows:

Mandatory certification of wastewater treatment operators can be described as a means toward an end -- that end being reduced pollution of America's waterways. Side benefits include: protection of the capital investments for employers; increased salary and status and pride in their work for operators; and a general, over-all improvement of living conditions for the public.

Study has shown that the principal stumbling blocks to the successful installation of mandatory certification programs are the municipal governments and other employers of wastewater treatment operators. They see mandatory certification as a threat to their freedom to employ whom they see fit, and as a method for operators to increase their status and salaries, possibly without merit. With some justification, employers do not feel that mandatory certification, of itself, will raise the performance level of the operators. This argument has merit, especially with a grandfather clause blanketing in all operators.

The key is education. Only education can raise the performance level of the operators. The employer must be sold on the basis of education. He must be assured that he will get something in return for relinquishing his right to hire whom he pleases. That something can be dollars saved through a better maintained plant. Certification, then, becomes a method for assuring that a certain minimum level of education has taken place.

Enactment of mandatory certification legislation requires that: (1) the State-local relationship atmosphere in the State be right; (2) the groundwork be carefully laid through cooperative action on the part of all supporting agencies; (3) the bill be carefully drafted with ample provisions for implementation; (4) the bill be introduced by a legislator or legislators who sincerely believe in such a program and who have sufficient stature to impress their colleagues with the importance of the program; and (5) energetic support be given by all parties while the bill is going through the legislative processes.

The State-local relationship atmosphere in the State is in effect a measure of the relationship between the state water pollution control agency and the employers of wastewater treatment plant operators and the operators as well. Unless these relationships are good, a mandatory certification program will be very difficult to achieve. Improvement in such a situation is largely a local matter and is dependent upon the people concerned at both the State and local level of government.

If the setting is right, achievement of mandatory certification can be accomplished by following the most effective procedures used by other states which are now on a mandatory basis.

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AMERICAN WATER WORKS ASSOCIATION ACTIVITIES
IN WATER TREATMENT PLANT OPERATOR TRAINING

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ITS TIME TO STOP TALKING

Although AWWA has been active in education for a number of years, the office of education with full time staff was opened in July 1968, with the mission to coordinate all education and training activities of national and sectional education committees and to develop and promote educational programs required by the water supply industry.

We reviewed the program, and of primary interest to me was the committee's finding of inertia, apathy and antagonism toward training by a majority of utility managers. This signaled that a change in our method was essential. We wanted flexibility and mobility in our thinking. We had to change. The world was changing rapidly.

I must admit that many things have changed much quicker than I believed they would. About 3 years ago, as President of the New England Chamber of Commerce, I had the honor to speak to the business leaders of New England at an annual meeting of the chamber. I made the following statements:

"During the past 25 years I have been a witness to more technological progress, more change, more alterations in the everyday life of man than have occurred in all of previous recorded history.

"Man has already traveled in space. Our rockets have photographed the moon's surface and transmitted the pictures 240,000 miles back to earth. Machines are in use that compute in a split second what would take scores of mathematicians weeks to accomplish. Cybernation is harnessing production to automatic controls and regulators. Atomic energy is providing electricity and means of powering our sea vehicles. Today only fourteen glass-blowing machines produce 90% of all the light bulbs made in this country of ours. And yet, what I have seen is but a prologue to that which lies ahead.

"General Electric Company says the day is at hand when an entire plant can be operated by numerical control, with all production processes in command of one central point. Philco has demonstrated entire electronic circuits for use in communications complexes packed into a space no larger than a 25 cent piece. The Laser beam will unleash a completely new science. It already is in use in delicate surgical operations. Coco Cola is already using ultrasonic energy to clean their bottles. Tomorrow this same energy will clean your home. Millions of people are working at jobs that did not exist before. All of us are at the threshold of a wonderful future for all mankind."

What I did not predict was -- "That an American would step on the moon ahead of the Russians and a year and a half ahead of schedule." And even more remarkable "That the New York Mets baseball team would come from ninth place, win the division title, win the National League pennant by defeating Atlanta in 3 straight games and then defeat the powerful Orioles in 5 games." That my friends would have been too much for my crystal ball to visualize.

However, what about the changes in the water supply profession and in the AWWA Education Program. With all this advancing technology the water utility game is in for its share but also our problems multiplied -- and to solve these problems, we need better and more enlightened managers.

In April 1964, speaking to the annual conference of the United States Chamber of Commerce, Mr. Leo Cherne of the Research Institute of America, an organization known for the accuracy of its projections, said, "The United States population will be 265 million in 1980" almost 75 million more Americans than today. These people will have to be fed, clothed, housed, entertained and educated. Our gross national product will have doubled to 1,160 billion, but our water consumption will reach 500 billion gallons a day.

In that same address he spoke of the tremendous technological advances that would be made and stated:

"Our total population will grow, but the men who will make the decisions, who will need to manage this vast undertaking will shrink, in fact, will be almost a million less in 1970 than in 1965. Management is not only the most urgent calling, but it is perhaps the most critically short resource facing us."

You need only to see the executive want ads in the New York Times and the Wall Street Journal to visualize how accurate his predictions were - back in 1964.

In AWWA, then, we determined that our current education program would be continued and stronger emphasis should be given to management training. Chairman Hudson stated the problem quite clearly at that time:

Training as an engineer does not qualify a man to be a manager. In addition to technical know how, the manager must learn to read the needs and sense the emotions of his subordinates and to understand why individuals often behave in unexpected ways and to learn what motivates them to good work performance.

Donald Heffelfinger, in the September AWWA Journal, spoke about the rapid technological change in our lives and in the water supply industry, and said the following:

"We must continuously extend our knowledge and improve our ability to maintain control over this rapidly expanding technology. This will require the continuing education of our manpower at all levels from manager to laborer. The manager can no longer make decisions by intuition, but must rely on logic, reason and fact.

"We must pursue an education program that will provide the training needed to understand and use the new technology and the skills to manage, operate and maintain our facilities for higher standards of performance."

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We took the position that to be effective and meet the challenge, it was important that we operate from known positions and establish a base of facts. We are now making a national study of current and future manpower and skill requirements for managers and operators in the water utility profession. The data will be analyzed, and specific training development programs will be established to meet our needs.

In determining and meeting these needs, it is obvious that the interest of top management is essential. No program can be successful or even survive without the full support of the water utility manager, and we will need to include the motivational aspects in our programs to obtain his support. These programs will require money and we have proposed that each utility clearly earmark funds in its budget in the amount of at least 5 per cent of management and operator salaries to support the training program.

Heffelfinger also said:

> "Management is the key to providing sufficient fundsfor instruction. The manager must first be sold on the vital importance of manpower training and necessity for budgeting funds: then he must sell his council or board on the significance of such funds. The public and officials must be educated to demand trained water utility employees."

No one knows for sure how much money is spent by American business in training. The Chase Manhattan Bank estimates $17 billion annually. Other estimates are double this amount. Whatever the figure, it is a fantastic sum.

It almost equals the amount paid out last year in dividends, and it is substantially greater than most people think, indicating that business is already doing an outstanding job. In the future, however, this effort will have to be broader and more extensive than it has been in the past, according to General Motors and General Electric.

Max Banzhaf, Vice President of Armstrong Cork Company, said that they were doing formalized training for forty-nine years and their training efforts have grown steadily year by year. They send people to colleges and universities for special courses and conduct schools using their own people as instructors, including top management, on a regular basis. He said and I quote: "The cost - and it really doesn't matter what the total cost is because whatever it may be, we are confident that it is one of the most profitable investments we can make, especially when considered in relation to the size of our annual payroll - and if you consider the cost and risk of replacing an employee who is a known quantity with one who is unknown." "To the manager in this fast moving day and age, who says that he can't afford to train or retrain employees, there is only one answer - if he expects to stay in business and compete, he cannot afford not to - or he may not be in business tomorrow."

This is not a unique point of view. It is shared by hundreds of other companies who do the same thing, including General Motors, IBM and General Electric, who have far more extensive training programs than Armstrong. Let me quickly bring you up to date on the rest of our activities: At a recent meeting of the AWWA Education Committee we took the following actions: We are reorganizing our Education Committee. The present committee was formed some time ago and was organized to produce certain specific and perhaps limited objectives, probably due to the lack of a full time staff. It took a long time to achieve many goals; however the remainder required a new approach. In review, new as well as some of the old objectives became apparent. In addition to our existing committees, a new committee is now being proposed: Management Development. Their mission will be to prepare and conduct a learning needs study and develop a management education program continuing into advanced levels. Also to stimulate, promote and encourage attendance by all water utility executive personnel. Two hundred and eight managers completed our management seminar programs last year and its success was largely due to WWEMA scholarship funds. In addition to forming a Manpower and Skills Committee, we are forming an Accreditation Committee. Their job will be to assist educational institutions to formulate valid curricula, instructors, and facilities in water supply training programs. Another committee will have the task of determining the feasibility and necessity of establishing a Water Operators School. Included in their task will be to determine the offering of 2 year associate degree courses in water technology in junior colleges, community colleges and technical schools, as well as universities. This might well be an area of joint venture with the water pollution people.

Still another committee will have the function of certification and examination. Eighteen of the states have mandatory certification. This committee will need to develop programs to stimulate each state to adopt mandatory certification and to prepare examinations for use in certification and associated training programs. To further the cause, AWWA is currently reviewing its policy on mandatory certification and we anticipate its passage.

A recently developed new education program has been our "Improving Water Treatment" workshops, financed by WWEMA. Our first effort was in Philadelphia on September 9-10. It was most successful and had near capacity of 43 students, and is now being conducted at Concord, California (which by the way reached capacity yesterday and had to curtail any more enrollments - we have started a waiting list), Denver, Chicago and nine other sections during 1970. An operator development committee is being formed to help promote this program and develop other needed training programs. This is our "holding the Tiger by the tail." We can't let go and we don't want to.

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We have several training publications about to be published: "Suggested Course Outlines for Water Treatment Plant Operator" - "Basic Manual for Water Treatment" and by mid 1970 a programmed learning course in basic chlorination. As was said yesterday, we hope that this will help standardize training curriculums. We have developed a recommended scope of activity for section education committees, a guide to help them find a direction, and suggested that its chairman be appointed for a 3-year term. We have found sections lacking continuity and as one chairman recently stated, "It takes a year to learn what it is all about and we never get off the ground." We have come a little way and we need to go much further. It is a wonderful challenge and I know that we are changing to meet the challenge for the future, and for a better American Water Works Association.

A few days ago I was told that, written on the blackboard of one of our high schools, were these words: "In case of atomic attack, the Federal Law prohibiting prayer in this school will be temporarily suspended."

How this will affect a change in the Supreme Court ruling, I can't say, but I applaud their humor. In conclusion, we believe that trained water personnel are necessary to meet these challenges of change, growth and higher standards. The future belongs to those who are best prepared. I submit that with the steps I have outlined that AWWA has stopped talking and started action. But I thank you for listening to me; however, I can't help but feel that my being here parallels what Thomas R. Jones, a highly respected industrialist, once told a convention of business leaders.

> "I have learned from experience that any answer I have for a problem is probably at best only half right. -- So I go to the best man I know in that field and get the answer. I take action on that other fellow's advice and get a reputation for being smart. Then I am invited to come and make speeches to the very fellows from whom I got the answers."

EDUCATION OF ENGINEERS FOR WASTEWATER TREATMENT PLANT OPERATION

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INTRODUCTION

The need for skilled operation of wastewater treatment plants is greater than that for most industrial manufacturing processes because of the large temporal variations in wastewater flow and composition. However, most wastewater treatment plants are in a primitive state with respect to process operation when compared with industrial processes. Gross failures, such as the bulking of activated sludge and "sour" anaerobic digesters, are all too frequent. Many other serious operational problems have been reported plant bypassing (1). In addition to these gross failures, there are significant variations in treatment plant efficiency, not only from one plant to another, but also from day to day and hour to hour in the same plant. Daily variations from 60 to 95 percent efficiency in BOD removal are not uncommon.

Maintenance of plant efficiency nearer the maximum by improved operation (Figure 1) could result in significant decreases in the pollutional load placed on our water

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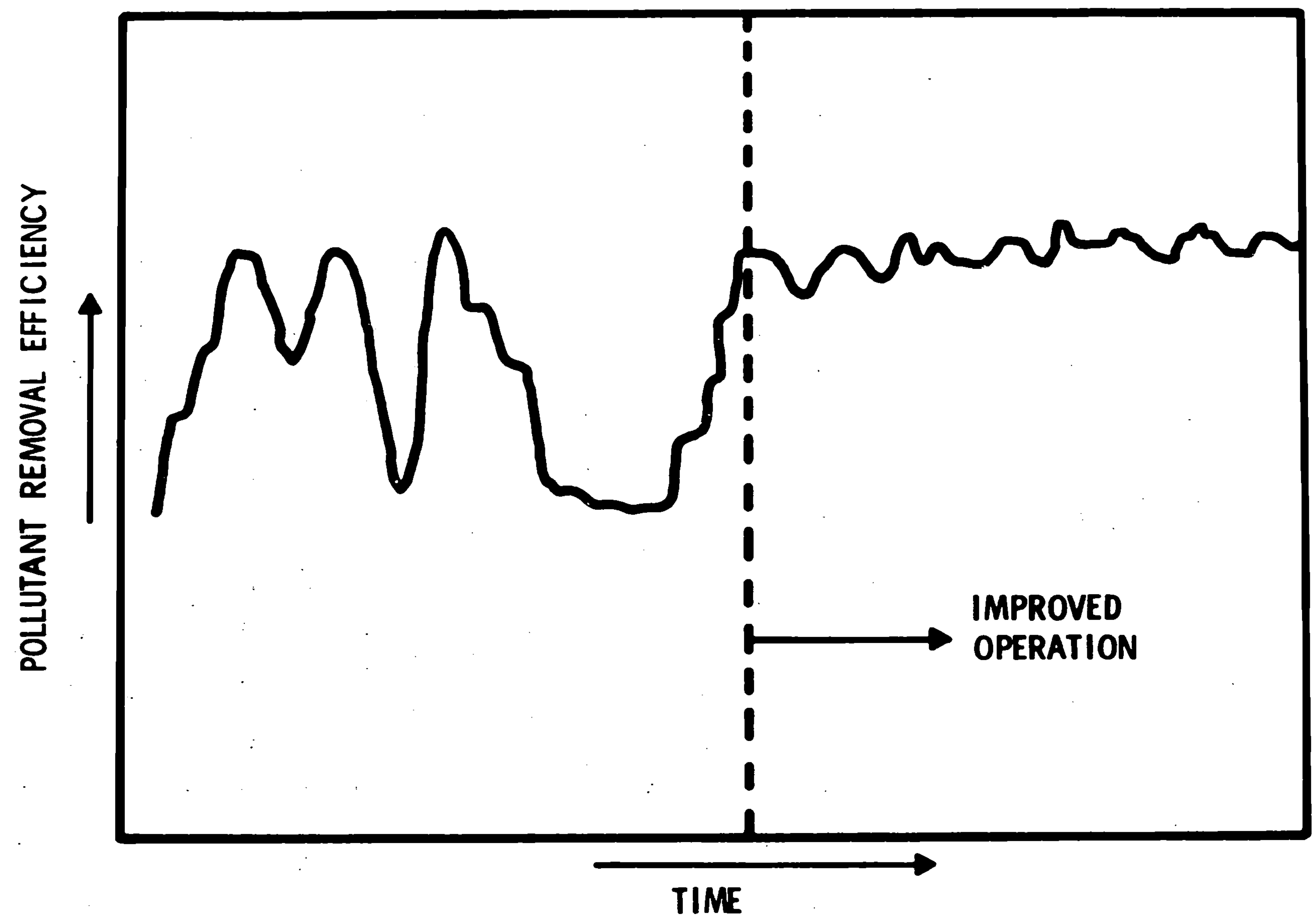

FIGURE 1. VARIATION IN EFFICIENCY CAN BE REDUCED BY IMPROVED OPERATION

resources. For example, consider a plant with average BOD removal of 87.5 percent. If, through better operation, plant efficiency could be maintained at 92.5 percent, the BOD load to the receiving waters would be reduced by 40 percent without increasing the maximum efficiency of the plant. Actual reductions may even be greater than this as demonstrated in the work reported by West (2) in which the average BOD discharge from a 21 MGD activated sludge plant was reduced from 40 to 9 mg/l by improved operation. This represents a reduction in BOD load on the receiving waters of 78 percent.

Another significant advantage of good operation can be improved productivity (3) through an increase in the amount of waste that can be treated per unit of plant capacity (Figure 2). There have been several reported instances where operators have been able to significantly increase the capacity of their plants above the design capacity through changes in operational procedure. For example, Gould (4) was able to double the capacity of his aeration basins for the activated sludge process by introducing the raw waste at intervals along the length of the basins. This idea has since been adopted by designers and is now accepted as a valuable modification of the activated sludge process.

Improved operation can be attained by increasing the quantity and quality of personnel involved, and by

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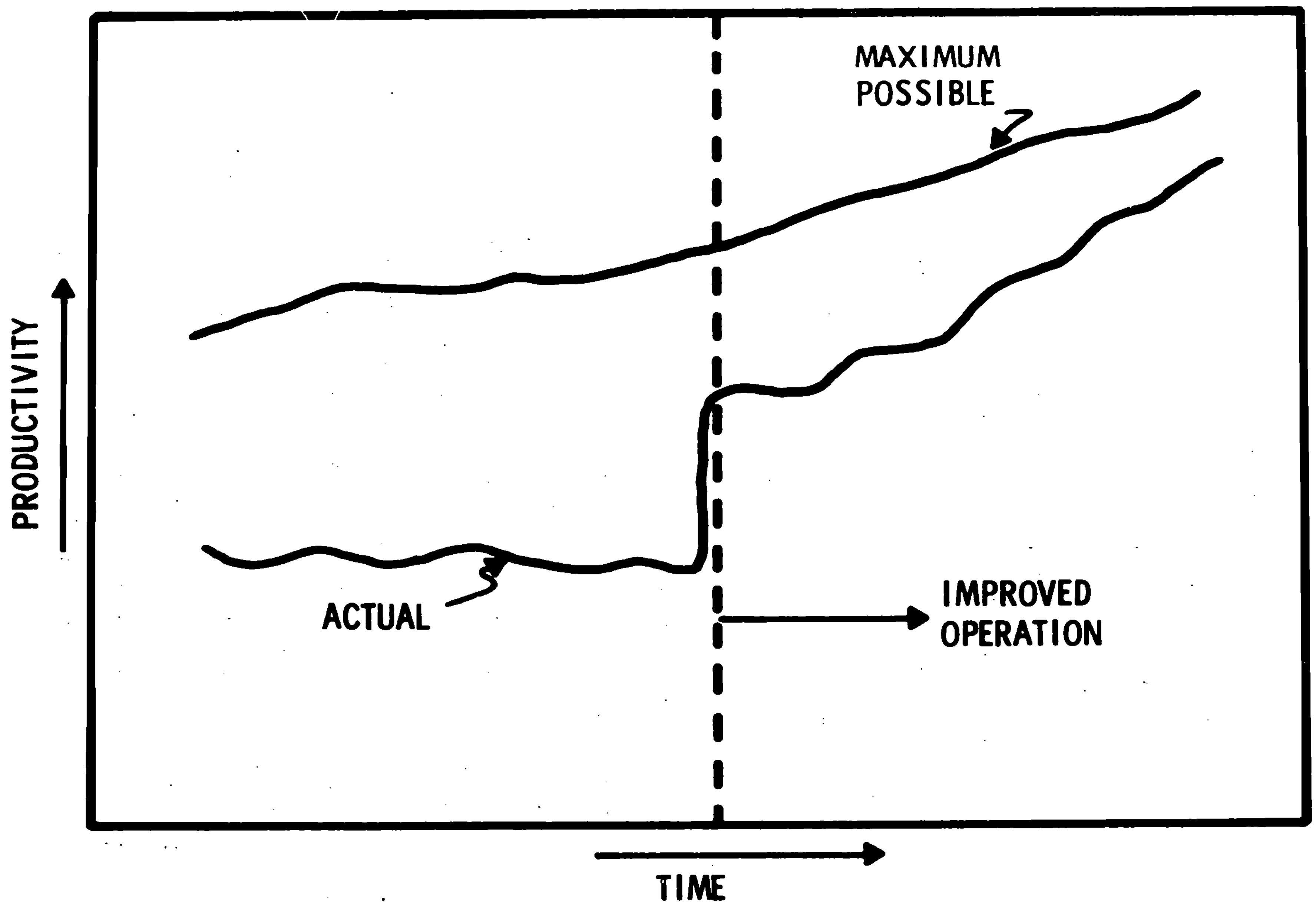

FIGURE 2. PRODUCTIVITY CAN BE INCREASED BY IMPROVED OPERATION

using modern control systems similar to those currently used in industry. The need for an increase in the quantity and quality of personnel is well known. The prospect of improving plant operation through the use of modern control systems is not as well recognized. Much of the work in this area has been more concerned with the replacement of personnel through automation. In the author's opinion, the improvement of product quality which can be obtained by proper control is equal to or greater in significance than any reduction in labor costs which may be obtained. In fact, the better control systems may require the same or greater labor costs because of the greater need for instrument maintenance and higher quality operating personnel. Perhaps of even more significance is the fact that human labor is being upgraded to do more meaningful tasks.

This paper will be concerned with both the control systems which may be used in plant operation and the educational needs of engineers responsible for plant operation. It should be recognized that the more advanced control systems which will be discussed have yet to be installed in wastewater treatment plants and engineers with the required knowledge to operate plants using these systems have yet to be graduated.

EVOLUTION OF PROCESS CONTROL

A detailed discussion of all possible control systems

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is beyond the scope of this paper; however, a sufficient range will be covered to illustrate the trend in process control.

MANUAL CONTROL

In this type of control (Figure 3), the operator uses his senses to determine the status of the process or measure the quality of the product. Any deviations from the desired operating conditions are corrected by changing those variables which can be controlled. The operator then observes if the correction is adequate and continues to make adjustments until the process is operating properly. The operator is the feedback to control the process and good operation is therefore an art which is dependent on the skill and intuition of the operator.

The control of many of our wastewater treatment plants has not advanced much beyond this stage today. An example of a variable which is still manually controlled in many plants is:

> Sludge removal from anaerobic digesters. The operator determines when sludge is properly digested and ready for withdrawal by observing color, texture, and odor of the sludge.

INDICATING AND RECORDING INSTRUMENTS

The first portion of the feedback loop to be mechanized was the sensing function. Human senses are replaced with indicating instruments (Figure 4) and automatic recording

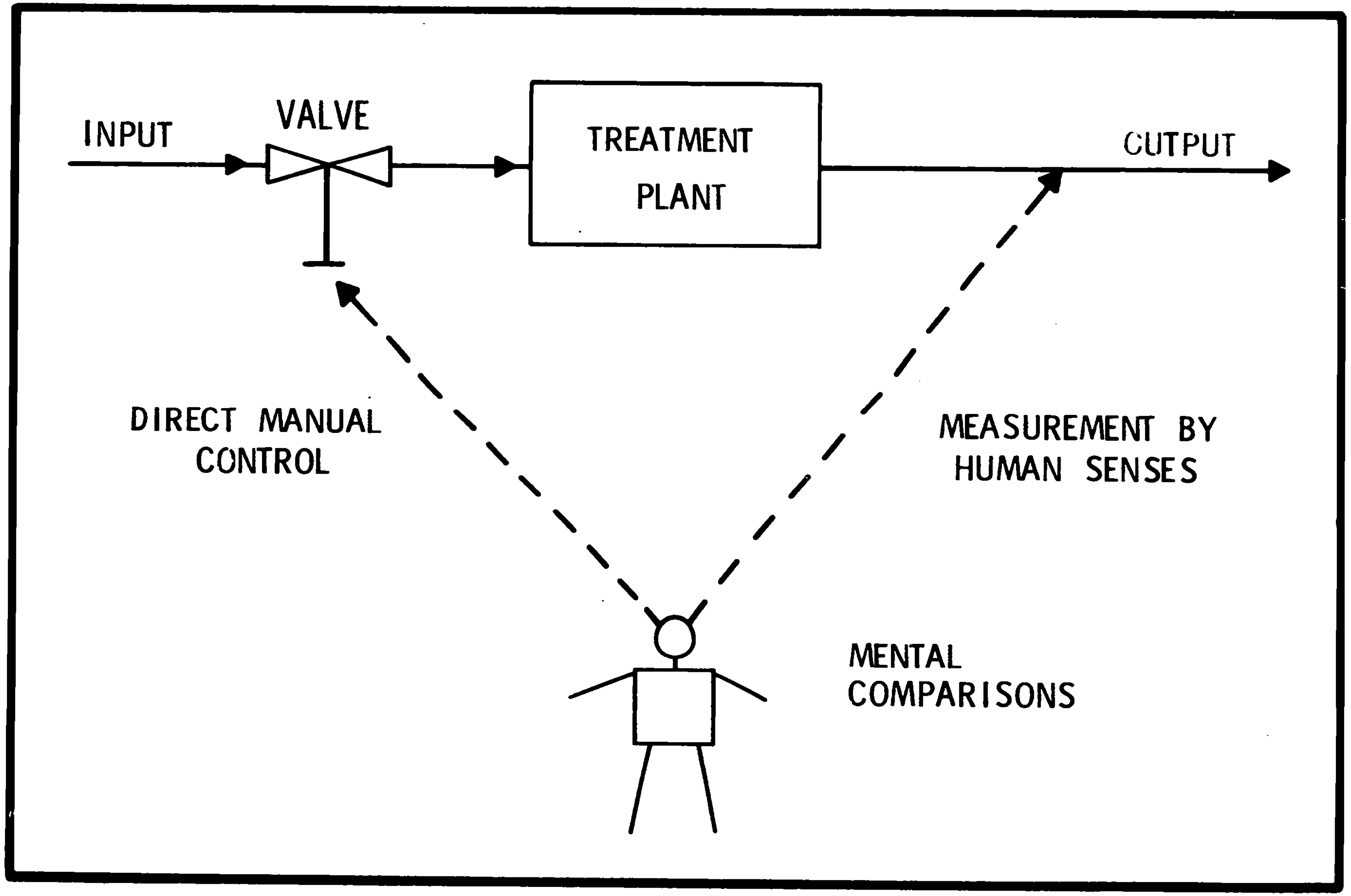

FIGURE 3. MANUAL PLANT OPERATION (after Lee, et. al.[5])

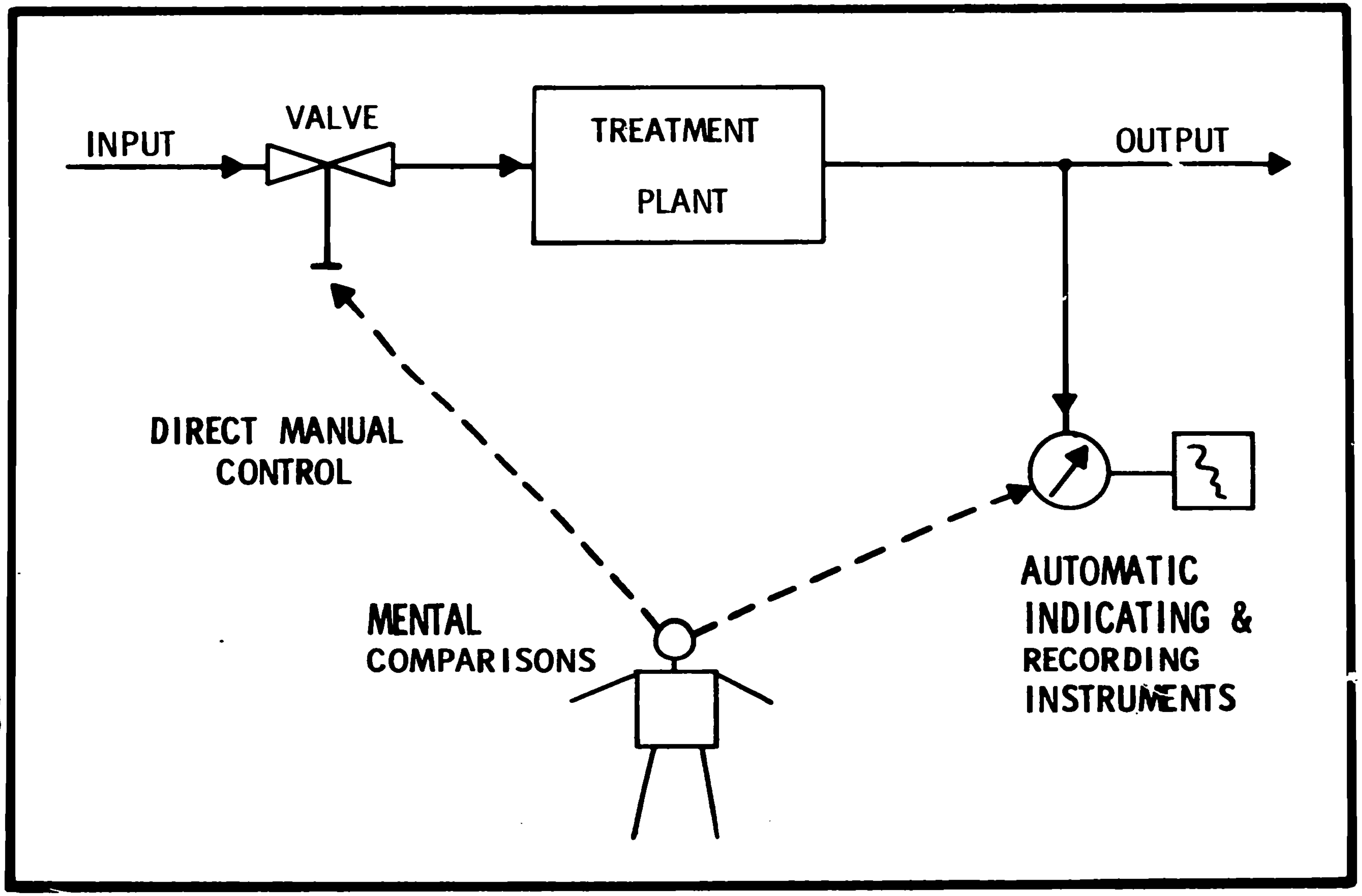

FIGURE 4. INDICATING AND RECORDING INSTRUMENTS ADDED TO PLANT OPERATION (after Lee, et. al.[5])

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instruments are added to give a historical record and indicate trends. However, these instruments serve only as an aid to the operator and it is still necessary for him to use judgment in detecting error and making the necessary corrections. Examples of indicating and recording instruments currently used in wastewater treatment plants are:

1. Flow and pressure.
2. Residual chlorine.
3. Dissolved oxygen.

Instruments for sensing are a very important segment of the feedback loop. Dependable and accurate instruments are available for many physical measurements such as pressure, temperature, and flow rate. Unfortunately, instruments for some of the critical measurements needed for wastewater treatment plant control are still in the development stage, thereby restricting the application of control systems.

LOCAL AUTOMATIC CONTROL

The next stage in the development of control came with the advent of the automatic controller (Figure 5) which removed the operator from continuous participation in the feedback loop. With these controllers it is possible to select values (set points) for the important process variables and have these variables automatically maintained close to their set points. The controller

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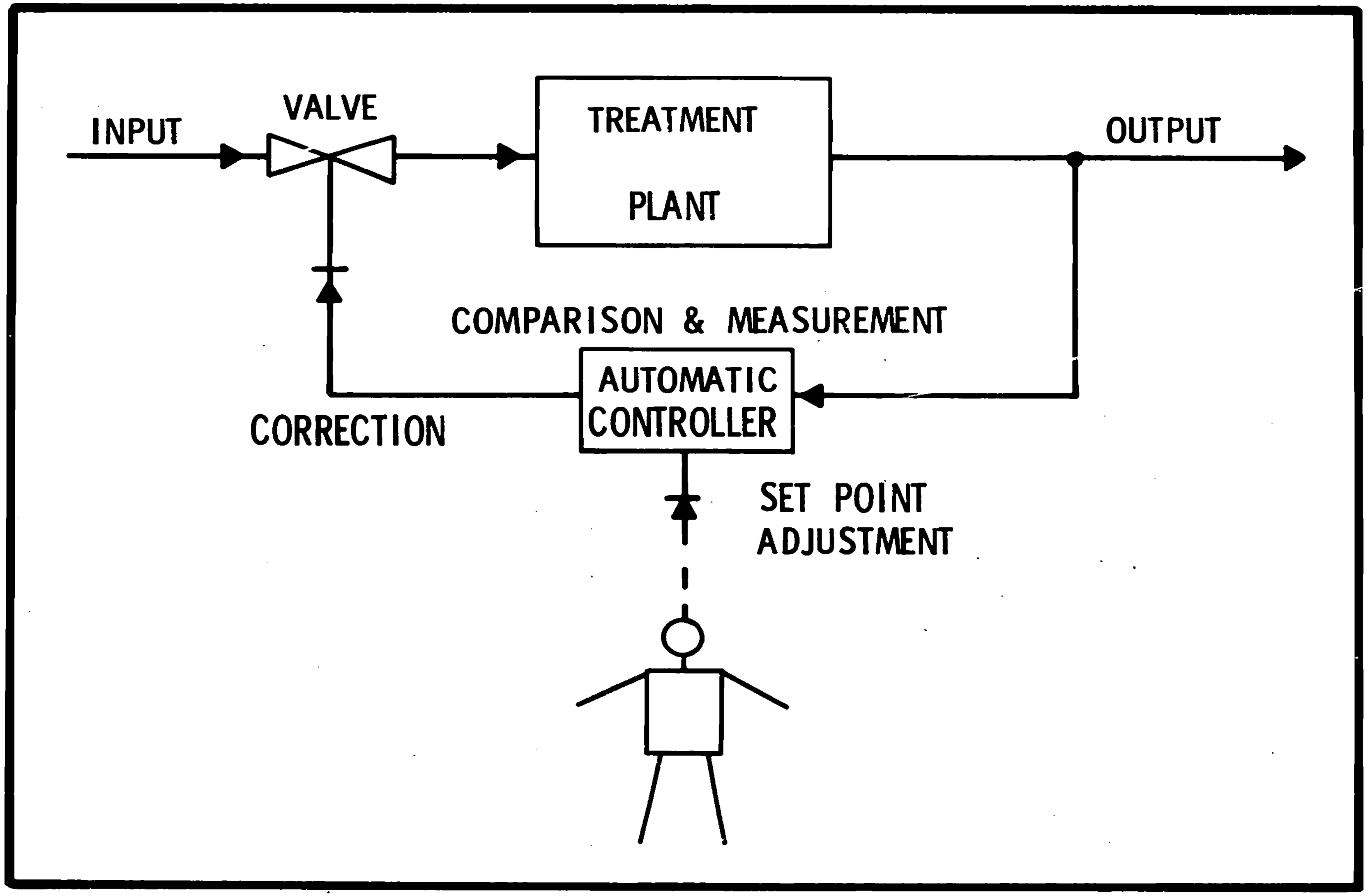

FIGURE 5. OPERATION BY LOCAL AUTOMATIC CONTROLLERS (after Lee, et. al.[5])

performs the functions of sensing and correcting deviations from the set point. However, the operator continues to participate in the feedback loop on an intermittent basis since he must select controller set points in the light of his judgment and experience. An example of the use of local automatic control in wastewater treatment plant operation is

> Effluent chlorination. The controller is set to maintain a specified value of residual chlorine in the plant effluent.

Problems encountered with local automatic controllers are determination of the proper set points and lack of consideration of interactions between variables.

CENTRALIZED AUTOMATIC CONTROL

Local automatic controllers are physically located near the process variables to be controlled. As the number of these increases, their maintenance and the monitoring and adjustment of set points becomes more difficult. The solution to this was the development of a centralized control room (Figure 6) where the controllers are brought together and mounted on a control panel. Graphic panels are usually used to display the key variables on a schematic flow diagram of the plant. This assists the operator in organizing and assimilating data and permits him to more quickly grasp the significance of changes in variables and take required corrective action.

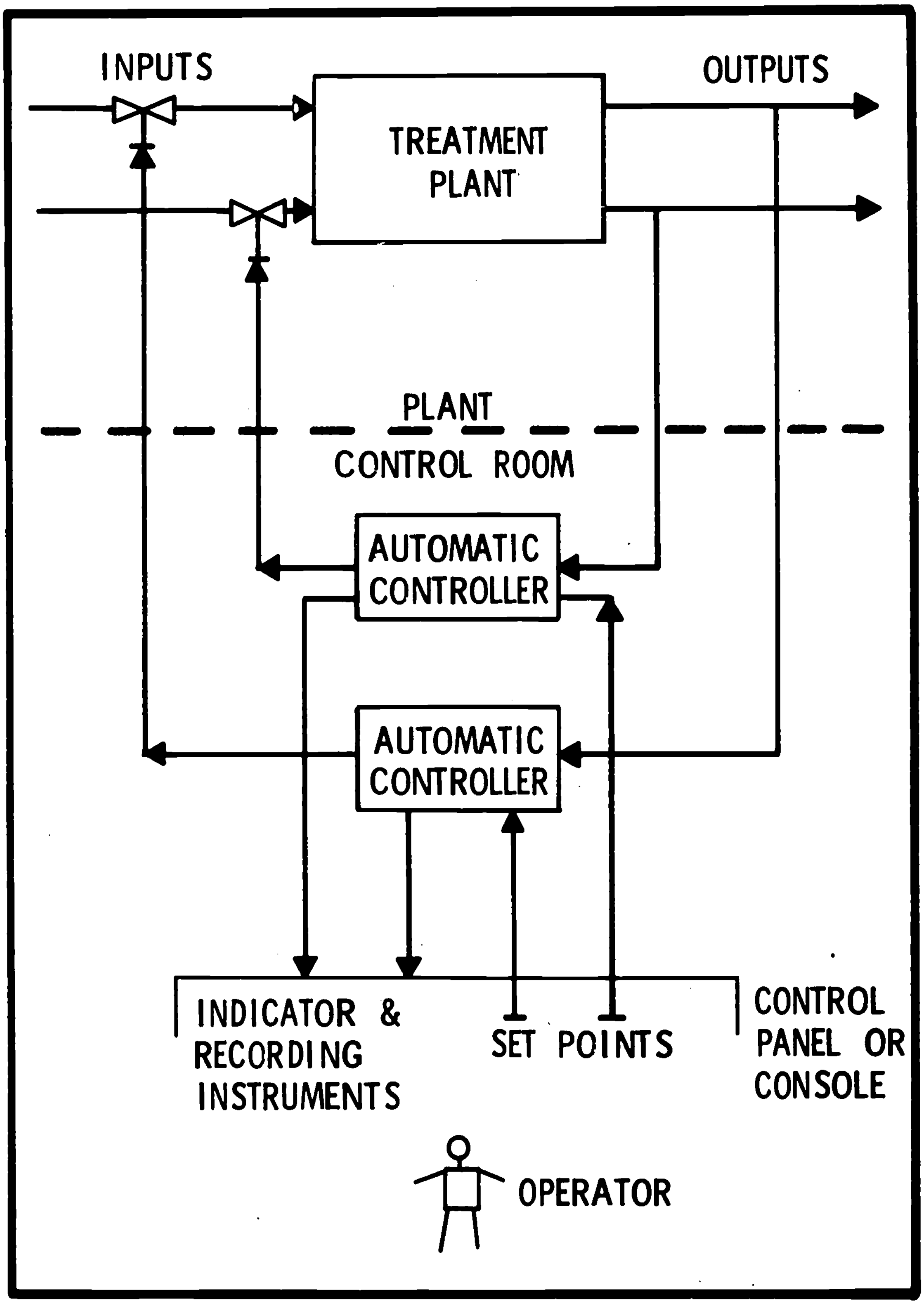

FIGURE 6. PLANT OPERATION BY CENTRALIZED AUTOMATIC CONTROLLERS (after Lee, et. al[5])

Some of the wastewater treatment plants in use today have centralized control rooms with graphic display panels. However, many of the items displayed on these panels are not automatically controlled, but instead require manual action by the operator.

COMPUTER PROCESS CONTROL

The digital computer first became available for plant operation in about 1958. By 1968 there were more than 700 computers in use for the control of industrial processes in the United States and it is estimated that this number will double by 1971 (6). Computers are now being considered for the control of wastewater treatment plants; and in July of 1969, Siemnes (7) announced that their process control computer would be used in the wastewater treatment plant for Stockholm, Sweden. Only a brief discussion of computer control can be presented in this paper; for a detailed discussion of such systems, the reader is referrred to the excellent books of Lee, et al. (5) and Savas (8).

The use of computers for process control can range from data processing and monitoring up to some form of optimal control and only these two extremes of computer control will be discussed in this paper. Most existing computer control systems are somewhere in between these two types. Prospective users should also recognize that although the potential use of computer control is very great, the

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adaptation of a process to computer control is a difficult and time consuming task. Considerable developmental work will be required for the application of computer control to wastewater treatment plants since these processes are complex and their dynamic behavior is poorly understood.

DATA PROCESSING AND MONITORING

Computer control can be installed in stages, and the first step is usually data processing and monitoring (Figure 7). The computer collects data, processes it into a more meaningful form, and displays it to the operator. The operator then adjusts the set points of his automatic controllers. In this mode of operation, the operator is still in the feedback loop and the computer only serves to assist him in running the plant. The computer itself does not take any direct control action. Typical functions which may be performed by the computer are:

1. Scan process sensing instruments, check for instrument malfunction, and convert raw data to meaningful engineering units.

2. Process data into a more meaningful form for the operator.

3. Monitor and report on the status of process equipment. For example, the computer can monitor the on-off condition of pumps, valves, motors, and compressors. It can check for overheating of bearings and excessive vibration of motors and compressors.

4. Compare process variables against high-low limits and sound alarms.

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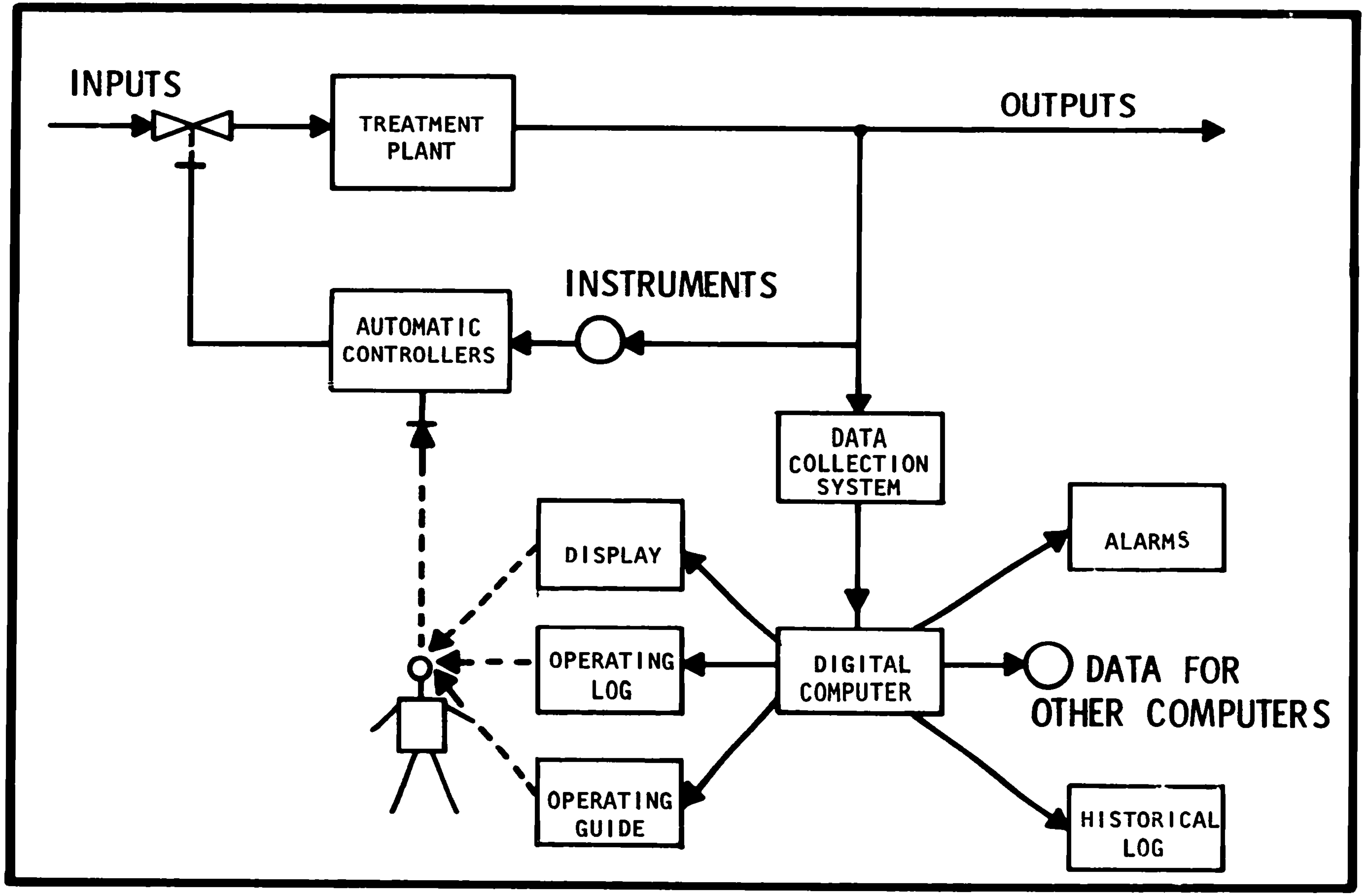

FIGURE 7. DATA PROCESSING AND MONITORING BY DIGITAL COMPUTER (after Lee, et. al.[5])

5. Prepare an operating log and display information to the operator. This can be in a tabular form, a plotted trend chart of a particular variable, or a tabular or graphical display on a cathode-ray-tube.

6. Furnish the operator with an operating guide upon request, such as instructions in case of an upset, or set points to be used to improve process operation.

7. Furnish data for other computers or provide reduced operating data to higher management.

OPTIMAL CONTROL

Although this degree of control has yet to be reached in most installations, it is a goal toward which most users are striving. In this type of control (Figure 8) the computer takes over the operation of the plant and controls it so that the overall operation is optimum. It is necessary to tell the computer what is meant by "optimum" For example, in a wastewater treatment plant "optimum" might mean to control the plant at minimum operating cost but with the constraint that the effluent BOD always be equal to or less than 20 mg/1. The computer would take into account all significant process variables and calculate the process conditions and process control changes necessary to obtain optimum performance. It would then initiate these changes.

The automatic controllers can be eliminated with the computer furnishing the signal to manipulate the process variables. This is called direct digital control (DDC) and, for processes where a large number of variables must

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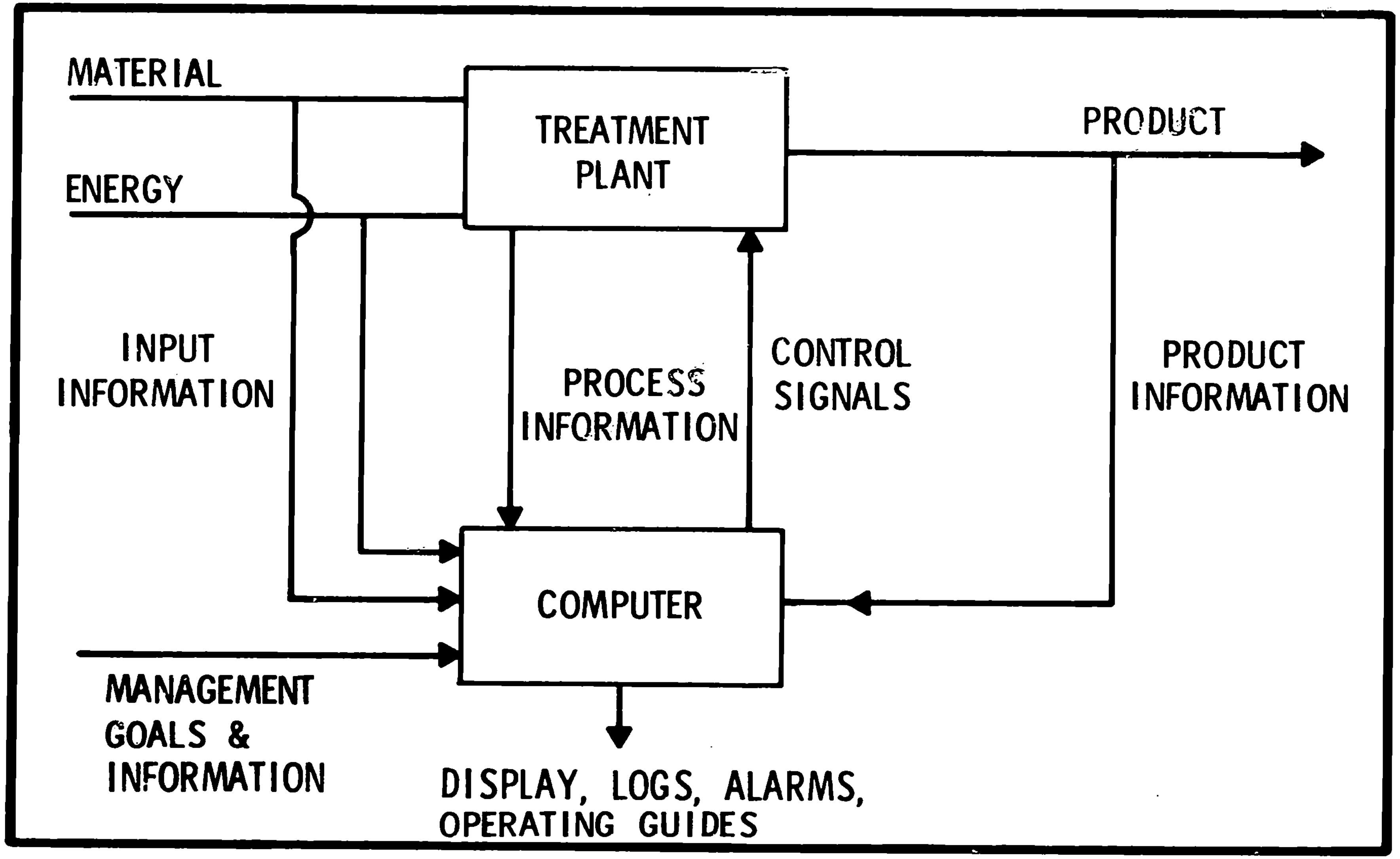

FIGURE 8. A COMPUTER CONTROLLED TREATMENT PLANT (after Savas[8])

be controlled, can result in considerable savings in capital costs for instrumentation. Feedforward control, using a dynamic mathematical model stored in the computer, can be incorporated to take control action before process upsets occur. Information for feedforward control is obtained by measuring the inputs to the plant. Some feedback control, utilizing information from the plant outputs, is usually incorporated since the mathematical models used are seldom perfect. Feedback control acts only after a deviation from the desired value has occurred; feedforward control prevents the deviation from occurring.

PROPOSED EDUCATIONAL PROGRAM

There will always be a need for a man in the control loop either on a continuous or an intermittent basis. The best example of this is the recent landing on the moon, where, even with the most sophisticated control system possible, it was necessary for a man to break into the loop for the final landing.

The type of control system selected must be suited to the environment in which the plant will be operated. Use of a complex control system would be nonsensical where proper instrument maintenance is unavailable or qualified operators cannot be obtained. It is essential that the qualifications of the men who will operate the plant be considered in selecting a control system. The more advanced control systems which have been discussed are only applicable to those plants where graduate engineers with the proper educational background will be in charge.

There is a need for this type of engineer at almost every level of operation. Industry, and the larger cities such as Los Angeles, Chicago, and Philadelphia, among others, have led the way by employing graduate engineers in plant operations. Rademacher (9) has discussed the great need in governmental agencies for engineers specializing in operations. Consulting firms also need more engineers of this type.

OPERATION vs DESIGN

Many environmental engineering programs have stressed either design or design-oriented research and have neglected plant operations. In addition, most designs have been based on the average inputs, or, at best, maximum and minimum inputs, and have not directly considered that inputs to the plant are highly variable with respect to time. These variations are the primary reason why control is needed and they must be considered in design as well as in operation. Future programs should strike a better balance between design and operation and will consider the inputs as functions of time. Some of the factors which should be considered in obtaining this balance are:

1. Operating personnel. The need for operation must be minimized through design when it is anticipated that plants will be operated by unskilled personnel. One way in which this is frequently done is by using oversized units to damp out the effects of fluctuating inputs.

2. Process stability. It is well recognized that some processes used for wastewater treatment are more stable than others and therefore require less attention to operation. Although this is of considerable importance, quantitative comparisons of the stability of different processes are not available.

3. Availability of space. Sizes of units can usually be decreased by increasing the operational effort involved. The best example of this is the manner in which the sizes of spacecraft have been kept to a minimum through the use of sophisticated control systems. Decreases in sizes of plants through improved operation would be of importance in our larger cities where space is at a premium.

4. Reliability. The effects on the receiving waters of failure to obtain the desired degree of treatment either continuously or intermittently must also be considered. A higher degree of reliability will be required for a plant discharging into a stream with no excess assimilative capacity than for one discharging into a stream with considerable excess assimilative capacity. Additional reliability can be obtained through either design or improved operation.

5. Financial. The balance between design and operation is influenced by the feasibility of investing in capital costs or operation and maintenance costs. It is the author's belief that an increase in the ratio of operating and maintenance costs to capital costs would result in better overall wastewater treatment for municipalities.

6. Flexibility. Another reason why industry favors investments in operation and maintenance over capital costs is the flexibility provided in decision making with respect to time. Capital can then be used to modify plants as technological advances occur. On a shorter time scale, it is conceivable that wastewater treatment plants may be operated at variable efficiencies

with respect to time in order to match the assimilative capacities of receiving bodies of water. Good operation would be essential in order to obtain this flexibility in efficiency of treatment.

Many of our current wastewater treatment plants have been designed to minimize the need for operation. Although this is an excellent policy for those plants which do not have good operation, it can penalize those where skilled operators are available. The intelligent operator could use much more flexibility than is usually provided and on occasion has modified the operation in order to obtain more control. Gould (4), for example, was able to improve operation of his activated sludge plant by varying the amount and point of introduction of raw waste along the length of the aeration basin. This additional control feature has since been incorporated into several new designs.

PROPOSED CURRICULUM

Since the first degree in environmental engineering is the master's degree, the following discussion will be concerned only with curricula for M. S. students specializing in process operations. A typical curriculum is shown in Table 1. The actual curriculum would differ somewhat for each student because of differences in background and objectives. It is assumed that the students pursuing this course of study would be recent engineering graduates

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TABLE 1

TYPICAL CURRICULUM FOR AN M. S. STUDENT SPECIALIZING IN PROCESS OPERATION

Course	Semester Hours
Fall Semester	
Analytical Chemistry	2
Physical Chemistry	2
Organic and Biological Chemistry	2
Microbiology	2
Unit Operations of Sanitary Engineering	3
Systems Engineering I	2
	13
Spring Semester	
Systems Engineering II	2
Unit Processes of Sanitary Engineering	3
Unit Operations & Processes Laboratory	2
Analog, Digital & Hybrid Computations	3
Elective	3
	13
Summer	
Water & Waste Treatment Systems	3
Special Problem	4
	7
Total	33

who have had courses in statistics and computer programming in their undergraduate curricula.

The chemistry and microbiology courses would be similar to those currently given in most environmental engineering programs but with more emphasis on automated methods of analysis. Chemistry and microbiology, along with the usual mathematics and physics of an engineering graduate, are essential in assisting the student in understanding how a process functions so that he can improve upon design or operation.

The unit operations and processes sequence would emphasize both design and operation of those units most commonly used in water and wastewater treatment. Commonality would be stressed; for example, the basic principles of biological oxidation and reactor engineering are common to the activated sludge process, the trickling filter process, and the anaerobic digester. The response of the units to variable inputs would be studied since this is of prime importance in operation. Control of individual units would be discussed and the factors which should be considered in obtaining a proper balance between design and operation would be examined. A laboratory is necessary so that the student may learn to operate pilot units and take, analyze, and present data in reports.

The portion of the curriculum which differs most widely from existing programs is that block of courses which stress the systems engineering approach. Three of these courses, systems engineering I and II, and analog, digital and hybrid computations, would be taught outside the department by specialists in these areas. In these courses, the students would learn the fundamentals of mathematical modeling, simulation, control systems, optimization, and other important tools of systems analysis. An important part of the computations course would be the "hands-on" use of analog and digital computers which are used for process control. The application of these tools to the design and operation of water and wastewater treatment systems would then be covered by environmental engineering professors in a later course.

The final course in the proposed program of study would be a special problem selected by the student in consultation with his advisory committee. The problem could be concerned with the design and/or operation of a particular unit operation or process or some aspect of an entire treatment system. A professional engineer, currently involved in design and/or operation, would be asked to serve on the student's committee to assist in injecting realism into the problem.

The attention devoted to the M. S. curriculum is not meant to imply that Ph. D. study could not be conducted in plant operations. On the contrary, the author has several Ph. D. students doing research in such areas as dynamic modeling and control of the anaerobic digestion process, stability of the activated sludge process, and computer control of wastewater treatment plants. It has been the author's experience that this type of research is at least if not more difficult, than the usual scientific or design-oriented research.

ECONOMICS OF IMPROVED OPERATION

The question may be raised that the use of sophisticated control systems or the hiring of graduate engineers for plant operation would be uneconomical. The author contends that BOD loads to receiving waters can be reduced by improved operation at a cost per pound of BOD removed which is less than that currently being expended for conventional wastewater treatment. An economic analysis has been made for a 100 MGD activated sludge plant (capital cost of $22,000,000) (Table II). The total cost of BOD removed is 5.1¢ per pound. If it is assumed that the average efficiency of BOD removal can be increased from 87.5 to 92.5 per cent by improved operation, then at this same cost of 5.1¢ for each extra pound of BOD removed, we could afford an additional investment of $154,000 per year for operation and maintenance or we could invest an additional $2,200,000 of capital in a control system. Since a computer control system can be obtained for $400,000 to $600,000 (8, 11) and M. S. level graduate engineers can be hired for $12,000 to $15,000 per year, it can be seen that improved operation is

TABLE II

ECONOMIC ANALYSIS
100 MGD ACTIVATED SLUDGE PLANT

Capital Cost	\$22,000,000
Debt Service	4.3¢/1000 gal.
Operation & Maintenance.	3.1¢/1000 gal.
Total Treatment Cost	7.4¢/1000 gal.

Assume average efficiency of BOD removal is 87.5% for an input BOD of 200 mg/l

BOD removed per 1000 gal.	1.46 lb.
Total treatment cost/lb of BOD removed.	5.07¢/lb.

Assume average efficiency of BOD removal is increased to 92.5% by improved operation

Additional BOD removed per 1000 gal	0.0834 lb.
Value of additional BOD removed at 5.07¢/lb.	0.4234¢/1000 gal.

Additional investment that would be justified

Increase in operation and maintenance budget for higher operator salaries, increased training effort, more personnel, etc. . . .	\$154,000/year
or	
Extra capital investment in control system	\$2,200,000

Cost data from Smith (10). Adjusted to June, 1969, USPHS Sewage Treatment Cost Index. Interest rate at 5% with 25 year amortization and maturation period for bonds.

economically justifiable. The economic calculations presented should be conservative. In many plants it may be possible to increase the average efficiency of BOD removal to more than 92.5 per cent. Improved operation should result in decreased utility costs and operating supplies costs. Improved productivity in the amount of waste that can be treated per unit of plant capacity may be obtained.

It is of interest to compare investments in controls for the wastewater processing industry with that of the chemical and petroleum industry. Figure 9, from Silva (12), shows the rate at which investment in controls by the chemical and petroleum industry has progressed since 1955. In 1968, the percentage of the total plant cost invested in controls was approximately 12 per cent. This industry apparently feels that additional investment in controls is profitable. For comparison, an investment of $2,200,000 in controls for the 100 MGD activated sludge plant illustrated in Table II would represent 9 per cent of the total plant cost.

The author has been unable to find a tabulation of current investments in controls for wastewater treatment plants. However, Salvatorelli (13) has reported an investment of 4.5 per cent of total plant cost in the monitoring and control system of a specific wastewater treatment plant. Since he considers this monitoring and control system to be the largest and most complete of its type ever constructed, the usual investment in controls

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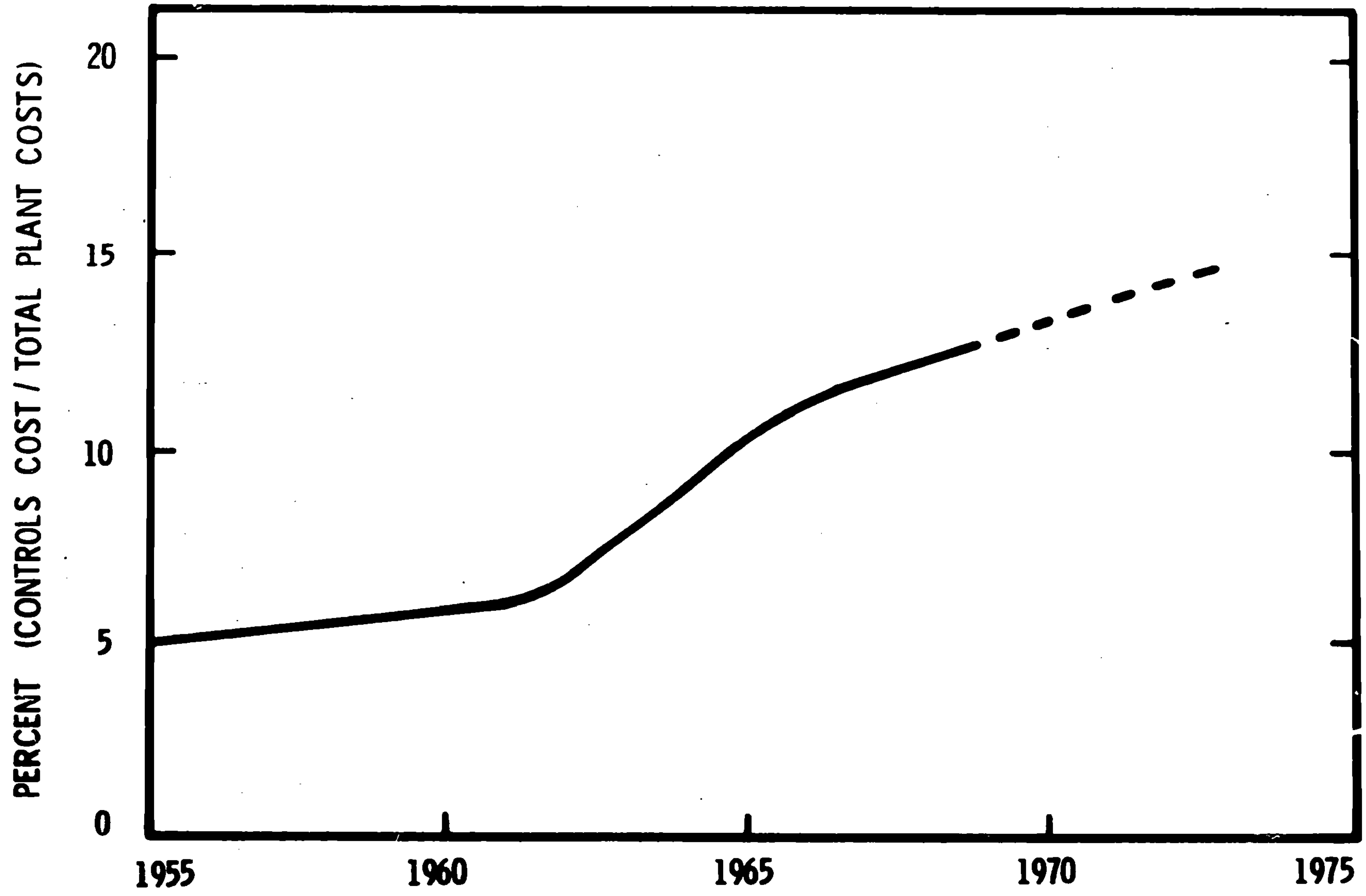

FIGURE 9. CHEMICAL AND PETROLEUM INDUSTRY INVESTMENT IN CONTROLS (after Silva[12])

for wastewater treatment plants is probably considerably below 4.5 per cent. It would appear that we could afford increased investment in plant operation whether it be in control systems or increased quantity and quality of operating personnel.

SUMMARY AND CONCLUSIONS

Wastewater treatment plants require skilled operation because of fluctuations in wastewater flow and composition. However, most plants are in a primitive state with respect to process operation. Improved operation could maintain plant efficiency nearer the maximum and increase plant productivity. It can be obtained by increasing the quantity and quality of personnel involved and by using modern control systems.

Control systems used in wastewater treatment plants range from manual control to centralized automatic control. Many of our plants are not far from the manual control stage and could make more use of conventional control systems such as indicating and recording instruments and local automatic controllers. Investigations are now underway on the use of computer process control for wastewater treatment plants. Although the adaptation of these plants to computer control will be a difficult and time-consuming task, the rewards can be substantial as demonstrated by the experience of industry.

The type of control system selected must be suited to the operating personnel of the plant. The more complex systems are only applicable to those plants where graduate engineers with the proper educational background will be in charge. In order to produce these engineers, environmental engineering programs in the universities must strike a better balance between design and operation. Students should be given the opportunity to perform research on the operation of existing plants.

Improved operation through the use of modern control systems and the hiring of graduate engineers for plant operation is economically justifiable. Additional BOD removal can be obtained through improved operation at a cost per pound of BOD removed which is less than that currently expended in conventional wastewater treatment plants.

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THE FUNCTION OF MEDIA AND INSTRUCTION

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SUMMARY

The book was the first mass medium that permitted a message sender to record his thoughts for use by receivers at other places or at another time. The communication technology existing today provides communicators with resources for improving large group or individual presentations, but requires the would-be communicator to identify his audience and their needs, specify his learning goals, select devices and design messages appropriate to the conditions under which they will be used.

BODY

Ever since man began trying to communicate some information to others, he has used aids: voice, gestures, and lines drawn in the sand with a stick. (AIDS: devices and materials used to assist a human presenter, not self-supporting).

Face-to-face instructors today use a chalkboard replacement for the stick and sand. Instructors also use technology in the form of opaque, slide, overhead, and motion picture projectors, television, audio tap recorders, and computers.

As man worked with instruction and technology he discovered and developed combinations of recording media that permitted students to learn without human instructors present. Analyzing the interaction between learners and recorded messages provided researchers with data and helped them to predict ways in which technology could be used more effectively to promote learning. For example, researchers have found that knowledge of results can contribute to a student's learning.

Today's communicator has such a wealth of instructional resources, he has a problem deciding which to use. He must look at his audience and decide whether instruction can best be carried out face-to-face, in large groups or small, or in isolation by individual learners. Large city banks with high turnovers of tellers use a classroom setting. The medical profession, scattered over the nation, faces the task of continuing the education of physicians where they are, in their respective offices and hospitals. The difficulty of getting many physicians together at any one time suggests an isolated individual approach.

Continuing medical education currently uses the print and audio medium. Their efforts with the distribution of television and radio messages have been troubled by scheduling problems. In an age when many homes have tape recorders and slide projectors, a combination slide-tape-print package seems to be a viable means for the mass distribution of instructional messages to such an audience.

The success of an instructional program depends on the systematic development of needs, an information network, the careful preparation of messages, and a clear statement of learning goals. The program can be efficient if the instructional materials are mass-produced for distribution. The program can be effective if the needs of the local organizations can be funneled to a central organization and combined so that a consensus of needs can be established.

The following list of readings is suggested for individuals wishing to learn more about the role of media in instruction.

Broadwell, Martin: THE INSTRUCTIONAL OBJECTIVES, Addison-Wesley, 1968.

Mager, Robert; PREPARING INSTRUCTIONAL OBJECTIVES, Fearon Publishers, 1963.

Kemp, Jerrold; PLANNING AND PRODUCING AUDIOVISUAL MATERIALS, Chandler, 1969.

A SYSTEMATIC APPROACH TO INSTRUCTION: INNOVATIVE AND SENSITIVE

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An approach of this nature is by definition, innovative, if only because of its prior absence. In order for this kind of instruction to take root and survive, a high degree of sensitivity must be demonstrated by the architect and implementors of the instruction.

A many-sided mandatory awareness is required, that takes into account the motivation and needs of the student for whom the instruction was designed, the institution that must "live with" the instruction, and the employer who is the recipient of the trainees, the product user, and, finally, society.

Innovations, such as systematic approaches to instruction, are, as Sir Francis Bacon described: "As the births of living creatures, at first are ill-shapen, so are all innovations. . . but though they help by their utility, yet they trouble by their inconformity. Besides, they are like strangers; more admired, and less favored."

Yes, innovations are sometimes hard to accept, as Bacon goes on to say -- yet in present day circumstances there are many worthwhile ones to consider.

This innovation -- the systematic approach to instruction, has as its prime focus the development, application and evaluation of approaches, techniques, and aids to improve the process of human learning. *Implicit* in its use is the concern that learning objectives should be carefully considered at the outset along with the means of assessing whether these objectives have been attained at the end of instruction. The best innovation *is interested as much with the needs of the learner as with those of the teacher.* In addition to stressing greater effectiveness in the learning process, it considers it equally important to secure greater efficiency in the management of this process. This innovation has a direct interest also in questions of utilization of manpower, and plant, and in the interrelationship of finance, planning, and administration. All *these considerations imply a carefully planned use of the resources available,* taking "resources" in the widest sense to include human, material, architectural, financial and other elements in the design of learning systems for education (Project Aristotle, 1967).

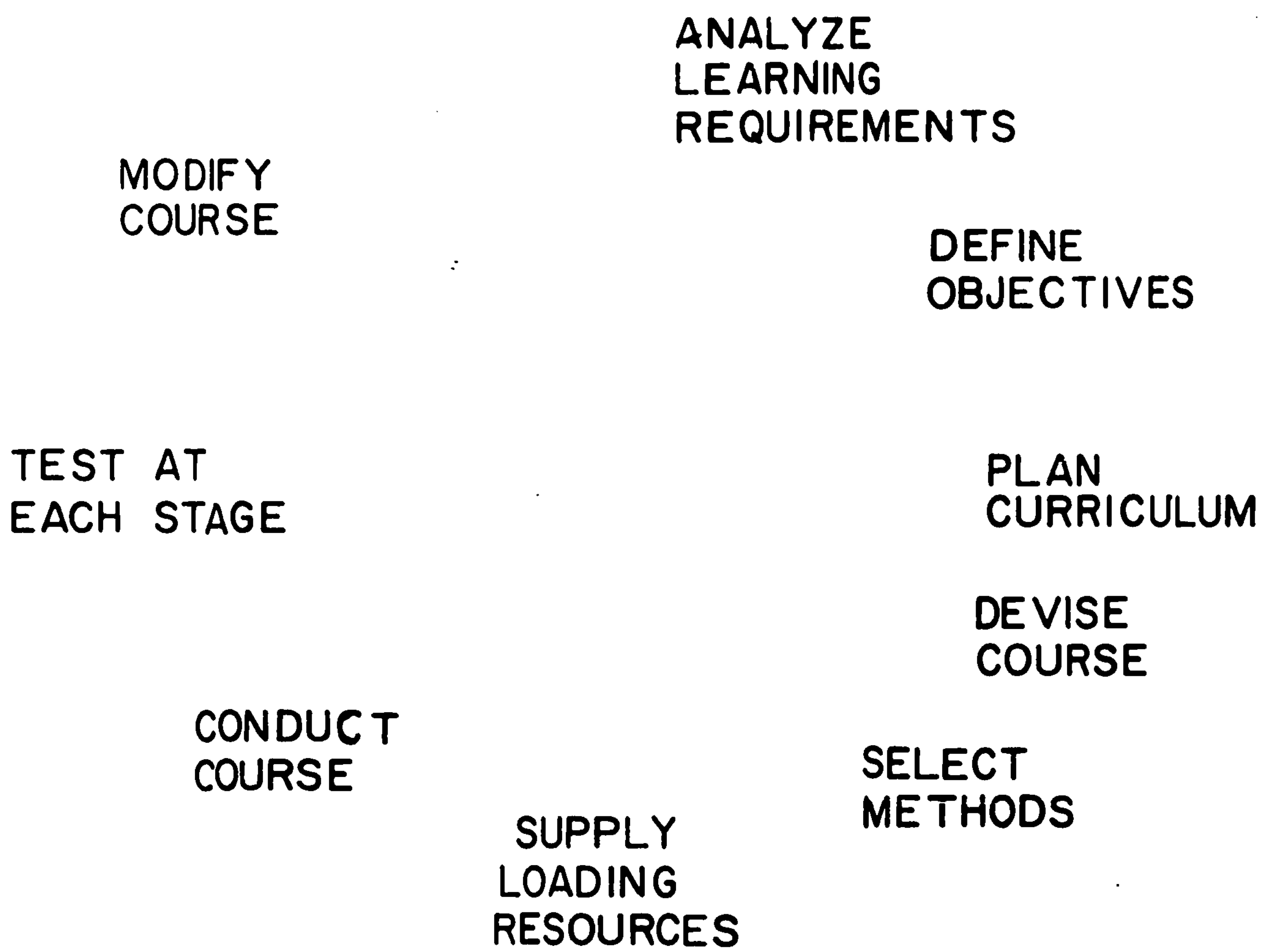
What is meant by a learning system? A learning system is essentially an arrangement of stages in education which follows upon a detailed examination of the purpose of each stage. The early stages are concerned with learning requirements from which follow defined objectives and a planned curriculum. These are succeeded by course constructions (complete with internal evaluation procedures) and decisions concerning methods and media of presentation. Later, when the required resources have been made available, courses are conducted experimentally and sufficiency tested. This process will provide valuable data to be used in its subsequent modification and improvement. *Finally the whole process begins again with a fresh examination of the learning objectives, emphasizing the fact that an education system must be cyclical in nature if it is to remain continuously relevant* (Figure 1).

Earlier we mentioned the necessity for a concern with sensitivity and awareness. You may ask, where does this come in? It has to do with the relevance of the education system and constant feedback from the curriculum. And perhaps most important, it has to do with the relevance of the curriculum to the smallest component in the total system -- the individual student.

Karl Deutsch has suggested that an organization that is to steer itself must continue to receive

> . . . a full flow of three kinds of information: *first*, information about the world outside; *second*, information from the past, with a wide range of recall and recombination; and *third*, information about itself and its own parts. Let one of these three streams be long interrupted and the organization becomes an automation, a walking corpse. It loses control over its own behavior, not only for some of its parts, but also eventually at its very top.

FIGURE 1. FEATURES OF AN EDUCATIONAL SYSTEM.



The innovation being described to you who are concerned with educational systems for operators of water control facilities has certain important features:

1. An attempt to include the influence of learners themselves on the initial construction and subsequent improvement of courses
2. The measurement of attainment
3. The matching of media and *human resources* to curricular development
4. The general attention paid to logical planning and
5. Use of the full potential of educational evaluation.

The innovation also *demands* much needed concepts and techniques for utilizing more fully the potential of educational evaluation. As Stake and Denny suggest in the 1969 *NSSE Yearbook*:

> . . . specific technical skills suited to educational testing and to educational research (to the surprise of some) are not perfect suited to educational evaluation. Mobilization of the appropriate skills will require recruitment of already skilled persons from other fields in addition to the training of personnel from our own ranks.

This innovation, to which I refer, is concerned with the learner and the background and experience he brings to the learning situation; a clear definition of the objectives for individual learning experiences integrated with the overall goals for an institution, a commitment for continuing evaluation and for an attempt to assess how effectively the goals and objectives have been obtained, and a corollary commitment to revise the instructions to reach the stated objectives.

Before we go any further, let us review what we mean when we use the terms "goals" and "objectives."

A goal is a statement that proposes desired and valued competencies, states of being, and/or general levels of proficiency to be achieved. Goals are achieved through the accomplishment of objectives within an educational entity.

AN EXAMPLE: All graduates should be well-informed and possess knowledge about the structures, processes, and functions of government.

An objective is defined as a quantifiable and/or observable achievement accomplished under specifiable conditions. Objectives should reflect the critical factors required for the achievement of a goal.

Objectives can be found directed toward meeting goals at *many* levels. For instance, objectives can be stated for curricular, course, and daily classroom assignments.

However, when initially specifying objectives for your program, it can be helpful to consider objectives primarily at two levels: curriculum-program objectives, and performance objectives. Sub-categorization, subdivision, striation, etc., can come from these.

Curriculum-program objectives are competencies that result from student involvement in curricula or programs of study (such as the water pollution control facilities program). They consist of the skills directly related to particular disciplines.

FOR EXAMPLE: A curriculum-program objective might be that students will be able to read different types of materials such as technical manuals, waste treatment bulletins, scientific articles, business forms, etc., with speed and correct interpretation.

Performance objectives are competencies that describe what the learner is to know, be able to do, or

> will demonstrate as a consequence of instruction, the important conditions under which he will perform, and the level of acceptable performance.
>
> FOR INSTANCE: When presented with a statement regarding a controversial issue in the area of treatment management, the student will seek out and examine at least two other viewpoints, identify each, compare and contrast, and then state, within a specified time, his final opinion regarding the issue. (CSBA, 1969).

Now that we have defined goals and objectives, we can talk about evaluation.

Most people are better critics than creators. So let's examine what questions might be asked if we were trying to determine whether a systematic approach had been followed for a course of instruction. Questions might occur in five broad areas: needs, objectives of the instruction, selection of trainees, training, program evaluation and review, and dissemination. These areas should be explored not only with the designer (D) and implementor of the instructional system, but also with the student(S), the institution's administration (I/A), and the recipient of the trainees (R/T).

Questions in the five broad areas might be as follows:

	TO BE ASKED OF:			
	D	S	I/A	R/T
<u>NEEDS</u>				
°What do you perceive as the primary purpose of the instruction? What need is this instruction fulfilling?	X	X	X	X

°What secondary needs are being fulfilled by this instruction?	X	X	X	X
°How did you determine these needs: national needs, problems of local district, interest and ability of staff, survey of needs of particular group?	X			X
<u>OBJECTIVES OF THE INSTRUCTION</u>				
°What are the objectives of this instruction? (For instance, to train 60 treatment operators in the dynamics of identification, diagnosis, and remediation of solid waste with specific characteristics.	X	X	X	X
°How will you know when these objectives are reached? What criteria and performance level are used?	X	X		
°In general, these objectives are being accomplished: fully ________ fairly well ________ only partially ________	X	X	X	X
°What objectives do you have that are not being accomplished? Can you cite reasons for this?	X	X		X
<u>SELECTION</u>				
°What were the criteria used in selecting candidates? [For instance, prior formal training (describe key components).] Rank given each factor?	X			
°How do the above criteria relate to your objectives?	X			
°Cite one criterion which relates to each instructional objective.	X			
°Are any standardized selection instruments used? If yes, which ones?	X			

°How was the information about the training disseminated? (Printed brochure, telephone calls to colleagues, etc.)	X	X	X	X
TRAINING				
°Is a "job description" of the final product of training developed? If so, can a copy be obtained?	X			
°Have performance criterion levels been set for each task in the job description?	X			
°What jobs may be available at the end of training that match the performance criteria?	X	X		
°Have the objectives for the training program been given to the candidates?	X	X		
°Have the trainees been advised, in writing, as to the performance levels required for successful completion of the training?	X	X		
°What provisions have been made for counseling trainees re progress toward criteria and suggested methods for improvement (i.e., individual conferences, videotape playbacks, written critiques)? How often is this accomplished (weekly, monthly, etc.)?	X	X		
°What work experiences are provided that approximate the trainees' eventual responsibilities?	X	X		X
PROGRAM EVALUATION AND REVIEW				
°Has a schedule been evolved for the instruction? How often is this revised?	X	X	X	
°Is there an allocation of funds to each event in the schedule ?	X		X	
°What procedures are periodically taken by the director and the staff to assess progress toward objectives?	X		X	

°Is an end-of-project evaluation planned? If so, how will this be accomplished? Is the development of instruments required?	X	X	X
°Do the students participate in the evaluation process?	X	X	
°What has been done to insure that this type of training becomes a regular part of the institution's program?	X		X

DISSEMINATION

°How are you publicizing the program? Please rank order the following methods: (1-most used, 2-second most used, etc.)	X		X

television __________
films __________
radio __________
press release __________
major newspaper __________
community newspaper __________
personal talks __________

°Have you made special efforts to inform others regarding the existence of the project? If so, how?	X		X
°How about community, county, and state officials, etc.?	X		X

Even as we pursue the systematic development of instruction, we should remember that the humanistic dimension of our approach should be paramount. We should not be deceived into thinking that the instructional product is more important than the process. Unfortunately, our civilization is often more oriented toward products and gadgets than toward a process or a philosophy. This is not to say that these products or gadgets have nothing to contribute. Many of the technological advances that can greatly assist education today are directed toward individualizing and personalizing instruction. P. Kenneth Komoski recently pointed out an ironic aspect of this situation:

> Many of today's teacher and student militants, alike, are voicing devastating criticism against "mass produced education" while more positive educational reformers emphasize the need to "individualize" and "personalize" school curricula. For while the militants are decrying the effect of the mass production techniques in industrial practices on education, others who are equally bent on changing the system are looking to the extended use of modern industrial technology to help them achieve an individualized personalized approach to learning.

Now you may ask what kinds of return or payoff you can expect from being systematic in the development of instruction? If you succeed in being innovative and at the same time remain sensitive to many of the factors discussed, what can be the benefits?

In an attempt to answer this question, let's look at some recent figures reported by Mayo (1969) relating to an effort utilizing programmed instruction (process and product) to Naval education and training.

Twenty-four PI-vs-Traditional experiments were undertaken. Twelve of these had data which could be used to evaluate differences in achievement using the two methods. These experiments were conducted for 3 to 226 students. Data of interest include:

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- The difference in mean scores was 6.12% in favor of PI.

- T.ere was a significant difference in scores at the 90% confidence level.

- PI was superior to Traditional in 11 out of 12 cases.

- The analysis of variance revealed that most (70%) of the variability in scores was due to differences between PI and Traditional rather than within the PI and Traditional groups (30%). In other words, there was not much variation in student performance across PI or Traditional courses; however, there were significant differences between the groups.

Fifteen courses, encompassing 4,083 students, had data which could be used to evaluate the differences in time required to complete a subject.

- The mean difference in time required is a 44% reduction in favor of PI.

- The statistical significance of the results is extremely high.

- Every test showed either a decrease in time for PI or no change.

Other findings in this study are as follows:

Low breakeven points (number of students) occur between PI and Traditional due to large reductions in student training time and the low cost of PI development resulting from use of Navy programmers.

Benefits resulting from increased job performance and reduction in instructor time are small in comparison with the large benefit resulting from a reduction in student training time.

The breakeven points are so low that only very low enrollment courses would not qualify for PI on a cost/benefit basis (assuming Navy developed PI materials).

Seventy-eight man hours were required to produce one hour of PI at Memphis at a cost of $280 (Navy personnel).

This is just one case study. There are others that document or describe the benefits of a systematic application to instruction (NSPI Journal, Training in Business and Industry).

As implied earlier, instruction does not operate in a vacuum. Cultural features are present as suggested by Niehoff (1969), and Hall's (1959) "Silent Language" or non-verbal communication is operating; your sensitivity to these factors may determine success or failure.

For instance:

1. Attempt to introduce the instruction with instructors who are interested in or committed to a systematic approach. The amount of new behavior which must be accepted and the amount of old behavior which must be given up should be minimal.
2. Select instruction which provides practical benefits in this world as perceived by the recipients, usually by improving their economic position.
3. The strategy of introduction will involve adapting to and working through the local patterns, particularly the pattern of local leadership.

4. Be flexible and establish good feedback channels from the recipients of instruction.

Above all, remember that you will be deriving data of many sorts as you go about systematizing and conducting your instruction. Don't be afraid to sprinkle your dishes of data with healthy pinches of clinical judgment and intuition. It makes for a far tastier instruction.

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TASK ANALYSIS REQUIREMENTS FOR UPGRADING OCCUPATIONAL INSTRUCTION

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BACKGROUND

Occupational analysis -- the detailed analysis of the tasks performed by an individual engaged in the actual routine of his occupation -- has been used for over fifty years as a basis for determining the training requirements for specific occupations. While the effectiveness of training sequences developed from such analyses has been varied, the basic rationale for such an approach continues to have an understandable appeal -- that is, the objectives of training are based upon the tasks required of an individual who is gainfully employed in the occupation.

Historically, occupational analysis techniques have emphasized the description of discrete segments of an occupation -- the jobs, tasks, or elements of tasks performed by the worker. Differences between analysis techniques arose from the way in which such terms as "job" or "task" were defined. Descriptions, for example, might have been limited to "operates a drill press" or have been

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expanded to "performs drill press countersink operations" or have included a listing of steps, i.e., "centers stock under drill, secures stock, lowers tool, raises tool, removes stock."

MORE RECENT ANALYSIS

Psychologists initially concerned with training problems associated with complex military equipment during and subsequent to World War II have suggested that a more precise description of individual performance, used with success in resolving more complex training problems, could also contribute to instructional development for most occupations.

Recent productive applications of more precise analysis in the design of training sequences have specified a level of proficiency which a worker must display when he is performing in an effective manner. Such an approach is relatively independent of task, job, or step size which tended to introduce ambiguity in many previous occupational analysis efforts.

An effective occupational analysis -- one that will be useful in planning instruction for the occupation -- requires a description of what the worker actually does, that is, what tasks he performs, what level of proficiency he displays during such performance, and the typical conditions under which he performs these tasks. The analyst must identify and describe a class of activities which the psychologist calls "discriminations".

DISCRIMINATIONS

The moment at which a worker makes a discrimination may be described as a choice-point in the ongoing task. At such a point, the individual attends to a particular cue -- usually something imbedded in the task itself -- which signals him that a part of the task has been completed satisfactorily. If the operator is skilled in his job -- that is, if he is performing at the required level of proficienty -- the cue or signal indicates to him that he should go on to the next part of the task.

Consider the case of a drill press operator engaged in the task of using a countersink bit. When the lowered press strikes the positive stop of a pre-set depth gage, a tactile cue exists which indicates to the skilled operator that his depth of cut is sufficient. It is this tactile cue which the operator must "learn" in order to be proficient. Stated another way, the operator must lower the tool until the positive stop is engaged with a *certain* pressure. When the tactile cue provided by the "feel" of a certain pressure against the positive stop is evident to the operator, the operator decides (makes a discrimination) that he can proceed to the next step -- that of raising the tool clear of the work. Discriminations such as this must be described by the task analyst. An analysis devoted to description only of task segments,

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e.g., lowers tool, raises tool, does not describe the content of the task necessary for development of relevant instruction.

In another case, correct discrimination by a worker may result in a change in the sequence of operations he is performing. Here some cue or signal causes the well-trained worker to alter his sequence of performance in order to accomplish the task to the required level of proficiency. This type of activity is characteristic of tasks generally described as trouble-shooting, i.e., involving "if this . . . then that" types of discrimination behaviors.

Tasks which require reliable inspection behaviors obviously require these discrimination skills. The routine behavior of an employee preparing food trays in a hospital must be altered by the absence of needed silverware. The fact that an employee knows where all silverware is kept, what silver should be on which trays, and where it should be placed on trays, will not assure reliable inspection and trouble-shooting behavior. Such behavior requires a separate but related set of discrimination skills which must be described and included as a part of training for the job.

Many of the discriminations made routinely by a skilled worker appear quite difficult to the trainee. An example familiar to some of us is that of shifting gears in an automobile equipped with a floor shift. The psychomotor discriminations involved in coordinating the clutch pedal and gearshift are "second nature" to an experienced driver, while the frustrations of a novice may mount to alarming proportions in the instructional situation. (This is particularly true if a well-intentioned parent is giving the instruction, as opposed to a driving instructor skilled in presenting a meaningful verbal description and/or demonstration of these discriminations to the novice.)

COMPLEX TASKS

When we face the problem of training for a complex task, that is, one which presents several alternatives to the employee for each possible course of action at an identifiable choice-point, we find that the employee typically is required to make discriminations in response to many factors which vary in subtlety as a part of the task.

Continuing the previous example, a truck driver who must shift shrough an entire series of gears will need to "know" the variable effects of various amounts of load on his truck, to "know" how the roughness of the roadbed affects his cargo, and to "know" what to look for when judging the gradient effect of the highway ahead.

An occupational analysis composed of a cumulative description of such discriminations a worker must be able to make permits the so-called "knowledge factors" of an occupation to be related to their associated "skills". The analyst must describe such discriminations in considerable detail to facilitate design of an adequate training sequence. Obviously, a complete description of job requirements would permit design and development of pretest instruments. Many prospective workers may have acquired relevant discrimination skills which, when identified, may be deleted from occupational training, thus reducing the cost of the training.

LIMITING FEATURES

An occupational analysis based upon observation of an individual's job performance obviously will be inadequate if 1) the worker observed does not possess the desired level of proficiency, i.e., he does not make the necessary discriminations or engage in the appropriate behavior based upon these discriminations, or 2) the analyst does not notice subtle discriminations made and acted upon by the worker and, as a consequence, does not include such discriminations in the analysis.

For these reasons, an effective analysis cannot be based upon one observation of one worker. Several workers must be viewed while performing the routines of the particular occupation. An individual worker is observed and his performance recorded. The recorded information must then be reviewed to provide the analyst with direction to specific acts or omissions which must be given particular attention when he views another worker. In this manner, a series of individual analyses must be conducted, each being followed by an interpretation of the data accumulated up to that time in order to guide further analysis.

Basically, the analysis process appears neat and precise. Applying the process in the real world is a different matter. The work of the analyst is complicated by job requirements which differ from one locale to another. Such local variation must be noted for two reasons. First, the analysis must result in a training sequence which emphasizes the common discriminations required of workers irrespective of locale. Second, the training provided to the worker must account for local differences. In this case, either general instruction must prepare each worker to handle any local requirement by anticipating the experience he is likely to gain on-the-job, or specific instruction must be provided by "tracking" trainees through instruction preparing them for precise local requirements. Thus the "real world" requirements of an occupation require observation of an adequate sample of workers to account not only for various levels of individual proficiency but also for varying local requirements.

Another complication arises if many current employees are "undertrained" for the occupation. If so, it will be improbable that the analyst will observe an ideal task performance -- and equally improbable that he will recognize that substandard performance is being observed. The evaluation of analysis data must include some outside check so that instruction based upon the data does not perpetuate inadequate skill levels. Individuals who logically may be expected to hold reliable opinions as to the level of skill required for the job (subject matter specialists) must be involved in the analysis process. When they are not available to join the analyst in observing the worker's actual performance, such specialists must be included in review sessions held after on-site observations of workers.

SUBJECT MATTER SPECIALISTS

It may be necessary for two levels of subject matter specialists to participate in the analysis procedure when the content of the occupation is rather technical. One specialist might be most familiar with the operational demands of the occupation; another specialist familiar with the theoretical demands imposed by subtle responsibilities of the job.

A consensus of these two levels of subject matter specialist is needed to provide a balance in the content of instruction imposed by realistic training cost limitations. Specifically, an engineer, physician, or other quite knowledgeable resource person might suggest a theoretical or historical emphasis beyond the immediate needs of the occupation. On the other hand, a supervisor might suggest a superficial coverage which neglects the basic theory

ERIC

necessary for an operator to benefit from his own experience subsequent to formal instruction. A realistic trade-off must be achieved between such conflicting emphases.

When a supervisor conducts on-the-job training, the trainee eventually reaches a level of proficiency permitting him to work "on his own", that is, under occasional as opposed to constant supervision. The basic reason for offering formal instruction at all in an occupation is that it is more efficient than on-the-job training. But it is not realistic to expect to continue formal instruction until each trainee is as proficient as an experienced worker -- the worker we observe when generating analysis data. Instructional costs suggest that the trainee should enter the occupation with a sufficient level of proficiency so he can work on his own under "occasional" supervision. The typical on-site supervisor has an opinion as to when trainee behavior appears to indicate an appropriate entry level of proficiency, that is, an ability to work "on his own". For reasons of cost effectiveness of instruction, it is essential that the analyst develop a description of appropriate entry level skills resulting from the consensus of opinion of many supervisors, each of whom will usually hold to points of individual preference.

However, experience indicates that supervisors generally are unable to communicate an operational description of the

ERIC

required entry level of proficiency in response to a direct request for such a description. It is the analysis data which provides the analyst with a common language which, in turn, provides the basis for communication with on-site supervisors.

DATA EVALUATION PROCEDURES

Subject matter specialists should review the data reported by the analyst after each observation. The subjective review should result in a consensus as to 1) the adequacy of description of the discriminations noted by the analyst, and 2) the inclusiveness of the analysis, i.e., whether any discriminiations essential to adequate performance have been omitted. As previously noted, such an omission may result from a low level of worker proficiency or from an oversight by the analyst.

The joint review and consensus by subject matter specialists should produce guidelines for the analyst's next individual observation. These recommendations should direct the analyst's attention to certain behaviors which, in the opinion of the specialists, should be either present in or absent from a proficient worker's behavioral repertoire.

Such closed-loop refinement of the analysis data should proceed until the analyst and the subject matter specialists are assured that further analysis would be uneconomical in view of the practical training considerations which exist. While the latter statement is rather indefinite, it is analogous to the decision any producer must make with respect to quality control inspection of his product. An investment in quality control -- in this case, the quality of training which will be based upon the analysis -- will be uneconomical to the extent that the resulting quality exceeds that demanded by the consumer. The quality of training to be provided for some technicians, e.g., health occupation employees, usually will be specified by a state board or similar regulating agency in terms of employee proficiency.

Occasionally an occupational analysis will be conducted to determine the certification requirements to be promulgated by a regulating agency. In this event, closed-loop analysis must continue until the data are sufficient to permit the certifying agency to specify a level of training which will safeguard public health and property.

TRAINING THE ANALYSTS

The basic training of analysts usually is accomplished through exposure to a college-level course that is typically offered in a Vocational or Technical Education Department. It is possible for analysts to gain a measure of skill by means of self-study with such materials as *The Training and*

Reference Manual for Job Analysts (1) or specific occupation guides as *Personnel Procedures for GS Positions* (2). Analysts, in either case, should receive additional instruction in behavior analysis enabling them to complete the type of occupational analysis suggested here.

Additional instruction should enable the analyst to deal with task elements in terms of the psychological concepts of association, discrimination, and behavioral chains (3). A typical set of instructional objectives for such added instruction of analysts might be as follows:

1 - Analysts should know the end-use of their data. Analysts will demonstrate their understanding of the end-use of such data when they can write directions enabling a novice to complete a simulated task, e.g. to assemble a puzzle-type model. The directions will be in the form of essential discriminations which the novice must make when performing the assembly task in an efficient manner.

2 - Analysts must be able to observe and record a complex task in terms of discriminations and chains. They will demonstrate this ability by observing an operator assembling, as in the previously cited example, a complex puzzle-type model and write an analysis in terms of ordered essential discriminations. The written analysis should be sufficiently exact to permit its use by the analyst in paragraph 1 above.

3 - The analyst must know how to describe tasks in behavioral language. He should demonstrate this knowledge through a sequence as he:

a) recognizes appropriate and non-appropriate statements, first by comparison and then on their own merits individually; next

b) corrects inappropriate statements; and finally

c) writes appropriate statements, given static descriptions verbally or by means of a series of still photographs. When the analyst is proficient in this objective, he will continue to the phase of instruction dealing with the objective in paragraph 2 above.

It has been suggested that appropriate basic and adjunct training will enable analysts to provide a detailed task analysis of maximum usefulness in the development of instructional materials and sequences relevant to the actual performance requirements of an occupation.

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2. U.S.Department of Health, Education and Welfare. *Personnel Procedures for GS Positions: Position Description and Performance Requirements.* Atlanta, Public Health Service Communicable Diseases Center, The Department, 1967.

3. Mechner, Francis. "Science Education and Behavioral Technology," in Robert Glaser (Ed.) *Teaching Machines and Programed Learning, II: Data and Directions.* Dept. of Audiovisual Instr., Nat'l Educ. Ass'n, 1965, 441-507.

APPENDIX A

PROGRAMING IS A PROCESS: AN INTRODUCTION TO INSTRUCTIONAL TECHNOLOGY[a]

By Susan M. Markle and Philip W. Tiemann

Objectives: After participating in this tape-slide program, the viewer will be able to:

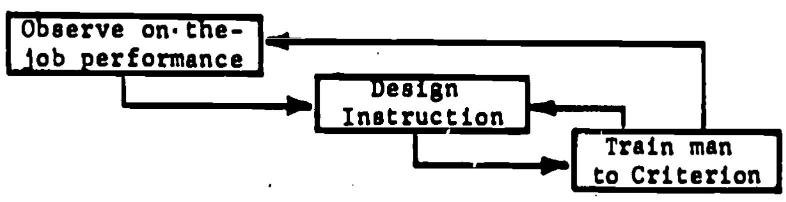
list the processes and/or products of the key stages in the development of quality-controlled instructional materials

describe the documentary evidence that should accompany a quality-controlled program

discriminate between objectives stated in specific terms and those not so stated

The remainder of this handout provides you with a set of notes coordinated with the main points of the presentation. You are encouraged to complete this outline as specific parts are referred to during the program.

2 THE TRAINING SYSTEM (simplified) 2



3 STAGE ONE 3

Question	Process	Product
What should the trainee be able to do at the end of instruction?	Task Analysis	Statement of ______

4 QUESTION ONE 4

___ Write instructions which clearly communicate the elements of simple tasks to new employees.

___ Write instructions which enable new employees to perform simple tasks without further assistance.

5 QUESTION TWO 5

The trainee will know how to use vernier scale instruments. ______

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[a]This answer sheet was used in conjunction with a slide-tape presentation by Dr. Tiemann.

6 Question	STAGE TWO Process	Product 6
How do we know that the trainee has achieved the objectives?	Analysis and Performance Item Construction	____________

7 QUESTION THREE 7

Objective: Correctly sack special handling items of a customer's grocery order.

Performance: Observe trainee, when sacking a test set of items, to --

- - sack canned goods first
- - double-sack wetpack items
- - insulate frozen items
- - sack crushable items last

Question: Would you discard the item if all your trainees perform correctly?

Yes ___ No ___

Question: Less-qualified trainees score 10%. You would revise:

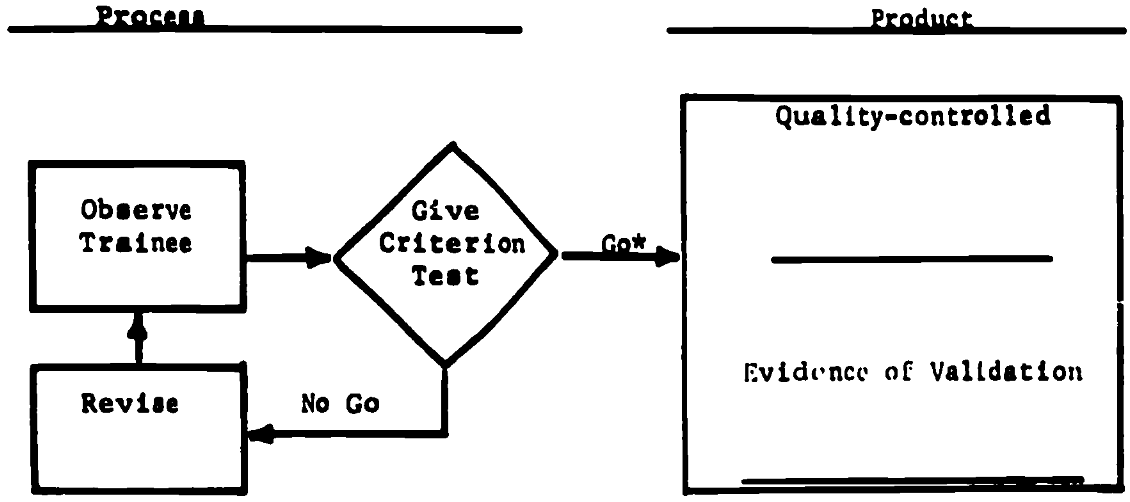
Your test item ___ Your instruction ___

8 Question	STAGE THREE Process	Product 8
What can the trainees already do?	Probe trainee behaviors with tests and observations	Statement of ____________ (and information to the programer on the starting point of instruction.)

9 Question	STAGE FOUR Process	Product 9
How do we get the trainee from where he is to where we want him to be?	Analyze the content and behaviors to be taught, Structure the material in "logical" order, and Select Media for presenting the instruction.	First draft of ____________

10 STAGE FIVE 10

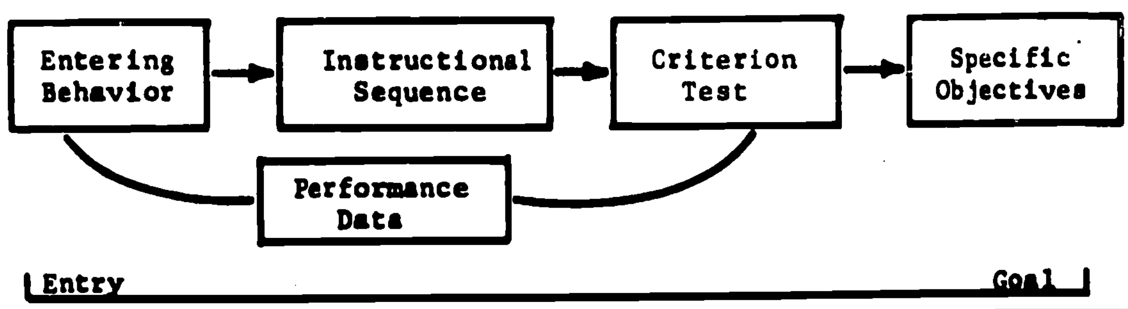
How can we get it to work and prove that it works?



*where "go" may equal 90/90 or any other standard.

11 PRODUCTS OF THE PROCESS OF 11

PROGRAMED INSTRUCTION



12 12

THE WRONG QUESTION:
"Is programed instruction better or worse than conventional instruction?"

THE RESEARCH AND DEVELOPMENT QUESTION:
How can we improve existing instruction by applying the programing process?

THE CONSUMER'S QUESTION:
What is the value of this particular program in attaining <u>my</u> instructional goals?

13 POST TEST 13

Mr. Smilie Salespitch enters your office with a new instructional package representing, he says, "the newest technique of instructional technology."

He says, "Scientific laboratory tests prove that trainees learn better from programs.

What information would you expect to have accompanying a truly programed instructional sequence?

He shows you:

1. The instructional sequence (programed???)

He should also show you:

14 FURTHER READINGS 14

On Objectives:

Preparing Instructional Objectives, R. F. Mager. San Francisco, Fearon Press, 1961.

On General Problems:

Good Frames and Bad, Susan M. Markle. New York, John Wiley & Sons, 1964.

Programed Learning: A Practicum, G. A. Rummler, et. al. Ann Arbor, Ann Arbor Publishers, 1965.

On Problems of Evaluation: Final Report of the APA-AERA-DAVI Joint Committee on Criteria for Teaching Machines and Programed Instruction. Published in the NSPI Journal October 1965 and March 1966 and in Audiovisual Communication Review, Summer 1966.

General background information and summary of the state of the art:

Teaching Machines and Programed Learning, Vol II: Data and Directions. Robert Glaser (ed.) Washington, National Education Assoc - DAVI, 1965.

Programed Instruction: A Guide for Management, Gabriel D. Ofiesh. New York, American Management Association, 1965.

Programed Instruction: 66th Yearbook of the National Society for the Study of Education. Chicago, Univ. of Chicago Press, 1967.

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SUCCESSFUL INSTRUCTOR TRAINING IN INDUSTRY

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Reprinted from JOURNAL OF ENGINEERING EDUCATION, Vol. 58, No. 2, October 1967
1967 American Society for Engineering Education

Perhaps the deadliest ingredient in an engineering teaching-learning situation is a knowledgeable instructor who cannot teach. He knows the subject matter and perhaps is an experienced engineer, but he is ignorant of what produces learning. And yet, as deadly as this ingredient is, it is as likely to be the rule as the exception. The problem results from having to use technically experienced and knowledgeable men as instructors, because it is often impractical to train experienced and competent instructors in the complexities of engineering. The solution must come in finding a way to make successful teachers out of successful engineers.

In the engineering department of Southern Bell, some two thousand people do work of a generally specialized nature and another thousand do the clerical support work. Since much of the work involves decision making that often can be done properly only after years of experience and training, it is seldom possible to take a qualified instructor who does not have this experience and training and put him to the task of teaching new engineers or engineering support people. The students have only to get vague answers to a few questions to realize that such a teacher is incompetent. For this reason, a course was developed that would produce instructors who were both subject matter and "learning" oriented.

BASIC GROUND RULES

First, some basic ground rules were established. This included the philosophy that teaching is a skill, just as lathe-operation, engineering design, and operating a typewriter are skills. Just as these other skills are learned, so can the skill of teaching be learned. Also, just as there are poor lathe operators and poor engineers and poor typists, there will be some poor teachers. But on the other hand, there was the prospect of finding excellent instructors, too.

Perhaps the most difficult ground rule to accept is that *there is no stereotype for a good teacher.* The ingredient that produces successful learning is sometimes difficult to pinpoint. However, some *activities* produce more learning than others. Such things as visual aids, student involvement, testing (feedback), etc., play a great part in any successful teaching job. Individual differences in instructors show up in *how* and *when* these things are used.

A final ground rule is that it must be assumed that the large majority of employees who come to classes *come to learn*. If they do not learn, then the instructor is at fault, not the employee. This simply means that the instructor has the accountability for the amount of learning that takes place. He cannot walk into a class, lecture for an hour, then come out and say, "Well, I gave it to them; if they want it, it's there for them." When the company is paying the salary and expenses of the students, as well as the cost of the training, such a nonchalant approach is not very practical.

EXISTING COURSES MISLEADING

The next problem was how to teach engineers to be teachers. If there is no stereotype, and each individual must find those traits and characteristics within himself that will make him a successful teacher, how can those traits and characteristics be brought out? First we looked at existing instructor-training courses, both within our company, and elsewhere. They nearly all had a common theme: They were "speech-training" oriented. Most of the teacher training we had done in the past tended to make the instructor a better lecturer and we had too much lecturing as it was.

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The existing courses taught the instructor to stand up straight, not jiggle his change or play with the chalk, make sure his lecture contained an Introduction, Body and Conclusion, watch the time, use visual aids and -- *presto*, out comes a successful instructor. However, when we taught this way, *we didn't get any more learning taking place.*

It was finally realized that we were not very good salesmen, because a good salesman convinces the customers they have a problem, then shows that he has a product that solves that problem. We had failed to convince the would-be instructors that *telling* students something was not enough. *We had failed to show them that they had a problem.*

Once this was realized, the task became easier. Since we were selecting intelligent, capable engineers as instructors, we had only to show them the problem, acquaint them with some possible solutions, and let them work out their own methods.

WHY VISUAL AIDS?

For instance, we never *tell* a potential instructor he should use visual aids. He comes to that conclusion on his own as a means of correcting a bad teacher-student communications situation. We make sure -- in the instructor training course -- to get him into this bad situation. We continue to allow him to teach by telling. He does it naturally and probably very well, *but the class does not learn.*

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The situation must be real and the students must be *trying to learn*. The subject matter must be simple enough to teach, easy to learn, and the expected results measurable. The prospective teacher will get the message quickly enough. Now he starts looking for a way to improve his communications, since he sees that telling is not as effective as he thought.

The next step is to allow him to experience a situation where *showing* (or showing and telling together) produces much more learning than *telling* alone. Again, it must be a real situation in which there is a fair comparison between lecture and visuals. Ideally the material to be taught (and tested) by each method should be as nearly identical as possible. In our case, we use the same figures and same number of words, except that in one case the words are reinforced with pictures and in the other they are not. In each case, the material is a *natural part of the course*, so as not to appear too strained or contrived.

There is another important step here that is often overlooked in instructor training, with regard to visual aids. Because it is always difficult to get instructors to use *any kind* of visuals, there is a tendency to be satisfied just to see instructors using visual aids, regardless of their effectiveness. Few instructors try to determine what it is about *seeing* that increases learning; most of them assume that bringing the eyes into play is all that is necessary. It is imperative that all instructors realize

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that not *every* picture is worth a thousand words -- only those pictures that really convey the proper message.

One way to instill the importance of having the best visuals to tell the correct story is to do some teaching with what appears to be easily understood pictures, but which actually do not convey a lasting image. Later, other visual aids are used which appear to be similarly prepared, but are designed to produce more permanent learning. When the group is tested on all the material, they discover that they can remember some of the things they saw, but not other material. Since visual aids are used in both cases, closer examination reveals why one set produced more learning than the others. The *prospective instructors determine this difference;* they are not simply told of it.

Another fault of existing instructor training courses is that they tend to treat visual aids as *teaching* aids instead of *learning* aids. This brought about use of the aids at the convenience of the teacher rather than the student. Teachers, when they were tired of talking, used visual aids to rest themselves. Or, perhaps even worse, teachers used visual aids because they helped them remember the points they wanted to teach. These were not valid reasons for using visual aids because no consideration was given to resting the *student* and helping *him* remember. Every effort is made in our instructor training to show that visual aids should meet the students' needs for learning, rather than the

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instructor's need for teaching. But again, this point had to be a conclusion drawn by the student teachers, rather than a fact told to them.

NEED FOR INVOLVEMENT IN LEARNING

What has been said about visual aids holds true for other aspects of the teaching-learning process. The prospective teacher may tacitly agree that involvement is a necessary ingredient to learning, but a real commitment to this comes only when he has experienced involvement in a teaching situation, then failed to experience it in another.

Ideally, the would-be teachers are given a boring lecture -- but one dealing with pertinent subject matter -- and allowed to drift almost to oblivion; then they are immediately presented a situation where they have to become involved. They participate, discuss, contribute, debate, etc., and find themselves caught up in the material. Then a halt is called, and a look is taken at the two contrasting situations. They evaluate the learning that has taken place, and *they* determine that much more was learned while they were involved. They noticed other things, too. They realize how miserable it feels to be bored, they find that time passes much faster when they are involved. They see that interest and motivation are higher when they participate. They find that there is a much stronger commitment to a point when they have contributed some of the facts of information leading to establishing that point. In reality, they have become students again, and they feel again what students feel in a teaching-learning situation. This feeling is absolutely necessary to developing empathy for their future students.

A teacher-training course that only *says* that involvement (or participation) is necessary, and does not demonstrate it, is falling short of the very point being made. Likewise, though, just demonstrating the point is not enough, unless several ways are given to get participation. The prospective teachers must see that it is possible to *force* participation in an acceptable way. Many of our future teachers come to us with the idea that the only way to get a student to participate is to call on him by name. We demonstrate in several ways that this is not so. We do it, as a natural part of the class, however, not just as a demonstration.

"Pick up your pencil" is one expression the new teachers hear a lot. Frequently during the instructor training we "invite the students back to class" by asking them to write something or list some items or answer short questions. What they have written is usually recorded in brief form on the board, and a discussion ensues. Since the students have contributed all of the information being discussed, they have both involvement and commitment.

What we have done is to *force* participation, first in writing something, then in recording it on the board. Similar methods are demonstrated. The new teachers weigh the various methods which are discussed in detail before they leave the course, and find the ones that suit their own needs and course material. Almost always, they find ways of improving on the methods we have shown them because now they are committed to the need for involving *their* students.

TESTING IN PROPER PERSPECTIVE

The matter of testing is always a subject that causes much debate and concern. The best approach is to let the student teachers find a strong need for feedback, so that testing begins to take its proper perspective. Nearly everything that is done in the instructor training course is measured in some tangible way. The results are always related to learning, and the new teachers begin to realize that *feedback* is essential in determining the success of the teaching effort. In fact, the prospective teachers, *as students*, begin to look forward to the results of the testing. When they have taught each other, they are eager to see the results because they realize that the measure of success in both teaching and learning is the amount of the material that has been absorbed by the learner. Therefore, in their practice teaching sessions, they want to test to see how well they have done as *teachers*.

Testing becomes much more meaningful when they see it in this light. Here again they developed this conclusion on their own, not as the result of simply being told by an instructor.

They learn another valuable lesson about testing: that testing is difficult to do. Some of the testing they are exposed to seems to test certain areas, but closer examination reveals that actually the test was not very good. On the other hand, some "sampling" testing seems superficial, but reveals a great deal of what the students have learned. They also recognize that because testing is difficult, evaluating the results is also difficult. They have a chance to be tested on simple material and make low grades and be tested on difficult subject matter only to make higher grades. Grades show up in an entirely different light after this experience.

Another extremely important fact that they discover about testing is that the results the students obtain are directly proportional to the efforts of the teacher. This is brought out by having two of the potential teachers teach the same material under identical situations, each teaching to only half the class. Neither knows what the other is teaching, nor does the rest of the class. The material to be taught is confined to a source sheet which contains facts, descriptions, concepts, and generalities. The two teachers perform separately, and at the end of the sessions, each group is tested with an identical test. An error analysis quickly shows that everyone in one group may have missed a certain question while everyone in the other group got it right. This may be repeated on other questions. In answer to "why?," the class quickly responds that the *teachers controlled what the groups got.* Unless the teachers made it available to them, they had no chance of getting it. This exercise, perhaps better than any other, causes the instructors to realize their accountability for the learning; the evidence is irrefutable.

RESULTS OF THE INSTRUCTOR TRAINING

Each subject relating to teaching and learning is treated in this same manner. It is introduced through some exercise that is a natural part of the teacher-training course. The would-be instructors become involved in the learning process and on their own determine the effectiveness of various methods. There are rationale and critique sessions that bring things to clear focus. Other subjects are discussed besides those mentioned here, including realistic objectives, the use of handout material, lesson plans, etc. Each subject is handled in a student-learning oriented way.

But what results come from this two-day instructor training session? Do the engineers leave as star teachers? Hardly! No more so than the lathe operator or engineer or typist is a star with no more practice than this. The

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difference comes later, because these engineers now realize that they are working at a skill, and a skill has to be practiced to produce the best results. They now know how to measure their skill, and they know the tools available. They have *a concern for the learning* that takes place in their classroom. Like any person practicing a new skill, they will make mistakes and they still need help. But -- also like any person in a new skill -- they now have the potential to succeed, if they are given time and patience. Fortunately, most of them reach their potential.

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AUDIOVISUAL SYSTEMS FROM A PROGRAMMING VIEWPOINT

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INTRODUCTION

The main value of a programmer's approach to the development of instructional material is his systematic identification of systems, specification of objectives, determination of content, and logical sequencing of instruction. Additionally, the programmer's commitment to evaluating his product in terms of objectives, and revising it as indicated by student response, is commendable.

Of secondary importance to the selection and organization of content is the format in which the teaching program finally appears. Whether audiovisuals should be used for a particular training program, and which media to use, depends on several factors.

The first consideration is whether audiovisual media serve the function required for a particular unit of instruction. In many instances, audiovisual media will be seen to be capable of serving the same functions as other instructional formats, such as a lecture or nonaudiovisual media (books, etc.). When there is no functional difference between audiovisual and other formats, or between particular audiovisual media, the selection of format must be determined by other considerations.

The determination of instructional format, therefore, is often made by considering instructional systems, distribution, and finances. For example, suppose any of a number of formats would suffice for training water plant treatment operators in a particular task. One would consider the instructional situations traditionally used. In the case of water pollution control, training has been offered historically through annual, short-term programs at colleges and universities, correspondence courses, regional conferences, or on-the-job in local plants. As these situations vary in terms of number of participants, amount of time allotted, and facilities available, the feasibility of specific instructional formats will vary.

One also considers distribution. The number of persons to be offered instruction affects the choice of format because it affects cost. Where the students are located must also be considered. For example, if materials are to be loaned out, filmstrips may be prefereable to slides in that they are all in one piece and therefore portions of the course cannot be misplaced. Finally, the utilization systems already in use throughout the country have a powerful effect upon selection of format.

Last, finances are always important. The cost of production varies with format, as do the costs of multiple copies of instructional items, mailing, and utilization systems.

Therefore, the information on audiovisual systems to be presented here will be relevant to a number of factors. We will survey audiovisual systems available in terms of their function, from a programmer's viewpoint, and will consider other factors relevant to the feasibility of their use.

SIMULATION

The programmer is interested in simulation -- giving the appearance or effect of the real thing. Simulation of the stimulus to which a student is to respond is probably the point where audiovisuals are most obviously useful.

Audiotapes obviously provide us with sound, which is not available in textual form. A good example of a learning situation in which sound may be necessary is that of learning to discriminate properly between functioning equipment and malfunctioning equipment.

In the area of visuals, let us first consider still images. It is often asserted that most of any subject matter can be taught effectively using still images -- an opinion to which most programmers evidently subscribe in their use of graphic and photographic images in book form.

How is the programmer to decide whether still pictures are adequate or whether motion is required? The rule of thumb seems to be this: If one can subdivide the task into discrete steps, then it can be taught through still images.

Included among media delivering still images are slides and filmstrips. From the standpoint of visual content alone, nothing favors their use in place of still pictures in publications. However, slides have the advantage that programs can be updated or otherwise revised economically. Therefore, even if the final release is to be in filmstrip form, it is convenient to use slides during the field trial period.

The addition of sound to the visual image, of course, adds strength to the format. A number of pieces of equipment are available to you today which deliver synchronized picture and sound. Of course, automatic slide projectors can be coupled with stereo tape recorders for sound/slide instruction. Such presentations are relatively easy to prepare, and can be used both in classrooms and for individual instruction.

In general, the functional differences between projected still visuals and published ones are not great: to choose between them, one must consider such factors as the ready addition of recorded sound to slides and filmstrips; the ease of presentation to groups rather than to individuals; the cost of reproduction; and the cost and ease of both revision and distribution

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Motion pictures and videotapes have at least two major advantages over the still image: they can show continuous movement, and they provide a delivery system wherein sound and picture are rarely, if ever, out of synchronization. In addition, many potential users who do not have the equipment with which to deliver sound and still images simultaneously, do have motion picture projectors.

The question of whether or not to use color is not necessarily synonymous with that of whether color is necessary to learning. If color is the cue to be learned, it is essential. However, color may be only one of several cues operating.

While the need for color is often proclaimed, much instruction is being accomplished using black and white media. Whether color is essential to teach a specific subject can be a very important question to organizations considering purchase of television production systems, since the purchasing cost of color video equipment -- especially cameras -- is considerably higher than that of black and white. Perhaps more importantly, the cost of technical personnel to maintain a high quality color production system can be quite expensive.

Some persons claim that color motivates the student to want to learn. In any case, the cost of color film, both still and motion, versus color television production, is minimal. Today the majority of motion pictures are produced in color, especially when they are destined for non-captive audiences, as in continuing education. And almost all slides are shot in color.

Again, cost becomes a factor in full color prints of high quality for publication. Slides and filmstrips may be chosen over books as the final format for distribution of instructional materials requiring full color reproduction on the basis of lower cost.

In summary, the function of imitating the real situation to which the student is to respond, or simulation, is met by audiovisuals in a number of learning situations: sound, still images, motion, and color can all be simulated by audio-visual media.

LEARNING PATTERNS

A second area of concern to programmers is learning patterns.

Linear sequencing or chaining is the traditional pattern used in teaching presentations in slide, filmstrip, motion picture, or television format. Though linear sequencing is most frequently used, other learning patterns are also possible. Discrimination and generalization are two such learning situations which call for particular teaching patterns.

Discrimination is the process of recognizing as different two or more situations which may appear to be the same.

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The situations differ in that they call for different actions on the part of the learner.

Generalization is the opposite learning situation. In generalization, the learner must see as similar two or more situations which are the same, though they may appear to be different, in that they call for the same action.

Both discrimination and generalization are learned most easily when all the situations to be recognized are presented simultaneously, so that they can be compared and their similarities and differences identified.

Audiovisual media can allow such simulataneous presentation of situations. One might present the situations to be compared in one slide, or in two or more slides on a multiple screen format. Similarly, one might present a series of situations with the appropriate response held on the screen nearby -- or superimposed.

STUDENT RESPONSE

A third area of interest to programmers is that of student response. The failure of audiovisual media as traditionally used to provide a format for overt response is well known. However, let us consider the state of the art now.

You may be familiar with teaching machines, some of which present audiovisual stimuli and require student response. You are probably also familiar with the idea of using motion pictures or slides to present information and a textual format for student response. At least one model of filmstrip projector can be so programmed that the audiotape asks a question, stops, and will not proceed until the student turns it back on. The picture, meanwhile, remains on the screen.

Learning is further enhanced if the delivery system allows intermittent stopping of the presentation to allow the student time to practice. Of course, books and slides allow this. A number of pieces of automatic audiovisual equipment also allow intermittent starting and stopping of motion pictures or videotapes. Even live television, traditionally used to distribute lectures, can be equippped to allow student response. A number of television systems are enhanced by permanent placement of straight-line telephones at the point of program origination and at viewing stations -- to allow the audience to telephone to the point of origin.

CONFIRMATION OF RESPONSE

Confirmation of response is no particular problem in using audiovisuals. For example, in learning terminology, the student might be asked to pronounce a word which is picked up by audiotape, listen to a replay of his recorded pronounciation, and then listen to a repeat of the instructor's "correct" pronounciation of the word.

In slides or filmstrips and motion pictures, question frames can be followed by blank frames or "holds," during which the viewer is to respond, and then by answer frames.

A variation of this technique is the "open-end" film which simulates a problem in which the audience is involved, then stops at a crisis point -- leaving the audience to resolve the conflict or discuss alternate solutions.

Videotapes are widely used these days to provide the student feedback. The student is videotaped as he performs a task. Later the tape is replayed and the student's performance is criticized by fellow students or the instructor. Videotapes can also be used to provide the instructor with feedback of his own performance and thus provide the basis for self-evaluation and improvement of his presentation techniques.

BRANCHING

Branching is a teaching technique of interest to many instructors. That is, branching in the sense of allowing the student to go to material tailored to his needs at particular points in the learning process.

For example, a comprehensive course in wastewater treatment plant operation might include portions describing (a) an Imhoff tank and trickling filters; (b) sedimentation, separate sludge digestion, and trickling filters; and (c) activated sludge. The student would be asked which type of plant he was to operate, and routed to the appropriate section of the course.

In the past, audiovisual equipment has generally failed to allow this flexibility. Yet branching is now possible both within media and among media. The random-access slide projector allows rapid retrieval of subseries of slides. The main track of the program might be comprised of, say, slides 1 to 50, with two 15-slide subseries on the same magazine. Other models of automatic equipment allow programming of two-track linear and multiple-branch audiovisual programs.

SELF-PACING

The term "self-pacing" is often used to describe an instructional sequence in which the content, or the number of steps used to cover it, may be varied. As had been indicated by earlier points, audiovisuals as well as publications can be structured so that portions of the overall content can be skipped. The extent to which this is possible and convenient depends on the particular medium and equipment.

But self-pacing also refers to the option of the student to proceed through a course as fast as he can manage. Audiovisual formats generally have the limitation that their viewing rates cannot be changed by the student. Audiovisuals are restricted mechanically; for example, motion pictures and video and audio tapes generally run at so many frames or inches per second.

Innovations are being made, however, in mechanical devices to speed up or slow down information delivery. For example, one device compresses speech without changing its tonal quality. Whether similar innovations in delivery rate of visual material are possible at a reasonable cost is a question which should challenge us.

EVALUATION

Finally, evaluation of instructional material is a matter of interest -- that is, testing instructional programs during their development for the purpose of revising them on the basis of student behavior.

It is because the production of audiovisuals, particularly motion pictures, is quite expensive that changes in the finished product are often resisted. Yet evaluation of the instructional effectiveness of audiovisual media is both reasonable and desirable. It can be carried out most economically at the storyboard stage. As indicated by Zuckerman (1954) use of a presentation consisting of slides made from "rough" storyboard art, together with recorded narration, may well allow prediction of the effectiveness of the final, polished production.

When the time comes that all audiovisual instructional material is routinely developed according to concepts of learning and communication theory, any revisions called for by tryouts should be so minor that they can be afforded --

even at later stages in production, such as the "interlock" stage, when sound and pictures are still separate but run simultaneously. Such testing and revision will certainly result in a better product.

CONCLUSION

We have surveyed some of the audiovisual systems available today in terms of their functions -- of the interests a programmer or other instructor has in them: simulation, learning patterns, student response, confirmation of response, branching, self-pacing, and evaluation. We have also considered other factors affecting choice of media systems -- production costs, duplication and distribution, ease of revision, and the likelihood of materials being returned from loan in good condition.

Now comes the question of what you as planners can do further in considering the format of audiovisual materials in learning programs for wastewater treatment plant operators.

Consultation is usually available from manufacturers of equipment on both the equipment and its utilization, including the best way to plan effective materials for use in the equipment. However, a less biased view may be obtained from audiovisual media or utilization specialists working in comprehensive production centers such as the learning resources, production, or communications centers operating in many universities.

A survey of instructional materials available in your field of interest may be difficult. A superficial survey run at my office revealed the existence of relatively few programs and audiovisual productions in your field. Further search for materials might best be aimed toward the Federal Water Pollution Control Administration's training programs and toward regional and State programs sponsored by universities and State and local governments.

As with development of any program, it is important to use expert help where available; to design specifically to the level of your audience; and to try out and revise the program prior to using it.

INSTRUCTIONAL MATERIALS ON WATER TREATMENT

Carl Hendershot's "Programmed Learning: A Bibliography of Programs and Presentation Devices" (4th ed., 1967-1968 with supplements, available from the author at 4114 Ridgewood Drive, Bay City, Michigan 48707, for $21.50) lists two programs in this field:

"Water Treatment -- Water Chemistry"
(AA90) 2-1/2 hours $5.50

"Water Treatment -- Water Testing"
(AA90) 2-1/2 hours $5.50

"Programmed Instruction Guide," 2nd edition, 1968. Compiled by Northeastern University. Published by Entelek Inc., 42 Pleasant Street, Newbury Port, Massachusetts 01950. About $12. (Entries arranged by Dewey Decimal system)

The "1968 National Medical Audiovisual Center Catalog" lists the following audiovisual materials (available on free short-term loan from the National Medical Audiovisual Center Annex, Station K, Atlanta, Georgia 30324):

16 mm motion picture --

M-6 "Municipal Sewage Treatment Processes" 1951

Filmstrips and records --

5-160 "Activated Sludge Plant with Vacuum Filtration and Incineration" 1950

5-138 "Primary Treatment Plants" 1950

5-159 "Trickling Filter Plants" 1950

F-132a "Filtration Plants" 1953
Series: "Small Water Treatment Plants"

F-165 "A Large Water Treatment Plant" 1954

F-146a "Functioning of Gas Feed Chlorinators" 1954
"Part I. Visible Vacuum Chlorinator"
"Part II. Volume Metering Chlorinator"

REFERENCES

Zuckerman, J. V. (1954) Predicting film learning by pre-release testing, *AV Communication Review*. 2: 49-56.

PROGRAMMED MANUALS

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INTRODUCTION

Under a grant from the FWPCA, the author and Dr. K. H. Mancy have been developing a series of programs on wastewater chemistry for treatment plant operators. In general, programmed instruction seems to successfully hold the interest of the operators, even when the subject matter is not directly related to their work in the plant. From our experience thus far, we are satisfied that programmed instruction can be applied in the training of operators on practically any level.

FEEDBACK

Previous papers have explored the principles of programming and the basic steps involved in writing programs. This paper will concentrate on the methods used in the evaluation of our programmed manuals by operators, and the results obtained from the evaluations.

The feedback of information from members of the audience you are trying to reach is a vital part of the preparation of any useful programmed manual.

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In preparing a standard textbook, it is quite difficult to obtain a point-by-point criticism, from either your colleagues or the intended audience. The method of organization of the textbook does not lend itself readily to a thorough, analytical review. Comments tend to fall into the category of generalizations or the category of typographical errors. Phraseology, structure, and general understandability are not covered to an appreciable extent.

The structure of a program, on the other hand, encourages comments from one and all on the content, on the organization, on the phrasing, and (most important) on whether you are getting the point across.

METHOD OF EVALUATION

To see how the evaluation has been conducted, examine the following general pattern:

1. Planning
2. Writing Rough Draft
3. Reviews by Content Specialists
4. <u>Revision</u>
5. Interviews
6. <u>Revision</u>
7. Small-Scale Evaluation
8. <u>Revision</u>

9. Large-Scale Evaluation

10. Revision

11. Publication

As you can see, the process involves four separate revisions. Actually, this procedure is somewhat idealized, and the actual number of revisions runs closer to six or seven.

To write a useful program, the author should have a fairly good general background and some teaching experience, but it's better if he doesn't know *too* much about the specific subject, at the beginning, for a reason which should become apparent as we discuss the procedure further.

In the planning stages, there were consultations with subject matter specialists, with operators, and with supervisory personnel, to try to pin-point three things:

1. What it is desirable for the operators to know
2. What the operators already know
3. What the operators want to learn

Notice that what it is desirable to teach the operators may not agree with what they want to learn.

During the planning stages, it was necessary to assimilate considerable amounts of information from standard methods and from various texts and articles. It is during this phase that the writer interposes himself between the expert and the student. If the writer is sufficiently naive, he will arrive at many of the misconceptions which would normally trouble a naive student. In the process of clearing up his own problems, the writer formulates approaches which can help the student to avoid these pitfalls. If the writer knows *too much* about the field, he overlooks many of the student's problems, and may actually have a more difficult time in understanding exactly what troubles the students who study the program later.

When the plans had been formulated and the rough draft had been written for Unit I, it was submitted for review by subject-matter specialists, both university people and supervisory people.

As a result of this review, changes were made in the content of the unit, and in the technical explanations.

During the writing of the rough draft and the revisions, efforts were made to get the reactions of operators. The technique of individual interviews is most useful here. We found a few operators who were willing to sit down and read the program aloud -- at first to the writer, and in later stages to an assistant.

These interviews are quite time-consuming, but we feel that the time is well spent. It gives the writer a feeling for the thought processes of at least some members of the audience. Intonations, hesitation, puzzled expressions, questions and yawns tell you much more than you can get from statistics.

There are definite advantages to having at least *some* interviews conducted by a trained assistant. The assistant feels no need to "defend" the program, while the writer may find it difficult to be objective. It's easy to discourage critical comments. To further avoid any tendency to whitewash the program, it's important not to bring the operator's supervisor into the picture.

In order to determine whether our program was meeting its objectives, pretests and posttests were devised at the same time, and tried out. Because of the nature of the material, we have been using written tests, although behavioral tests or simulations are of more value with programs, as a general rule.

After interviews with one operator near the top level of the intended audience, and one near the middle, plus further reviews by theoreticians and supervisory personnel, another major revision was made.

A small-scale evaluation was then carried out by mailing the tests and the program to 6 to 12 operators in various parts of the country, interviewing an operator near the lower edge of the audience, and sending the program to two or three more reviewers.

After another revision, the program was sent out to 40 to 50 operators; in this large-scale evaluation, we tried to get as wide a selection as possible, from the point of location, classification, education, plant size, and so forth.

CURRENT STATUS

The evaluation of the first unit of our projected series is nearly complete, and one "last" revision is being made to get the material ready for publication. The remaining seven units are in various stages, as may be seen in the following table:

	Completed	In Process	Dropped Out
Interested?	103	5	142
Pretest Unit I	84	4	15
Unit I and posttest	40	29	15
Pretest Unit II	34	2	4
Unit II and posttest	15	12	7
Pretest Unit III	7	3	5
Unit III and posttest	3	4	0

As the table shows, we approached 250 operators by mail. Over 100, from 13 states, agreed to help us -- without pay. Of these, 84 actually completed the pretest and received Unit I. Forty have completed the unit and the posttest. Nineteen of those who started the unit dropped out before starting Unit II. This is a drop rate of 1/4, which is certainly reasonable, considering the fact that Unit I involved about 8 to 10 hours of unpaid work. Incidentally,

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attempts were made to find out the reason for each dropout, but it's very difficult to figure out which men dropped because of a difficulty with the program -- very few will admit this.

Using the same method, the drop rate for the second unit comes out to be about 1/3. This unit was much more difficult than the first one, and involved a great deal of thinly-disguised chemistry.

The third unit is barely beyond the interview stage; three of the subsequent units are at the interview stage, and the final two units are in the planning and drafting stages.

The mail evaluation by operators is a very slow procedure, since it's on a voluntary basis. However, the use of volunteer evaluators provides a deliberate weeding-out process, since it's these same "volunteers" who will probably be the men that *use* the program.

Incidentally, reviews by theoreticians and supervisors are even slower than reviews by operators; there seems to be no reasonable way to avoid this. If the reviewer is well-versed in the field, his time is bound to be at a premium, and a thorough review of one unit will probably take even longer than the 8 to 10 hours an operator puts into it. We have been fortunate in finding a few people who have been willing to spend the time required to give us meaningful comments.

The following summary indicates the response from expert reviewers, on the first three units:

	Copies Sent	Comments Received
Unit I	43	25
Unit II	27	9
Unit III	10	3

The figures given are approximate. We tried to send each new unit only to those who had commented on previous units, but we slipped up a few times.

As mentioned above, most of the reviewers made only brief comments, but a few gave us detailed analyses. In general, the comments were favorable. Of course, *lack* of comment may be interpreted as an unfavorable response, so it's difficult to obtain any precise data on the reviewers' attitudes.

INTERPRETATION OF DATA

The interpretation of the data from the operators is somewhat more meaningful. In the first place, their responses are much more detailed, and in the second place, we have pretest and posttest data as a measure of their progress.

Because of the number of revisions, it's not possible to obtain a "statistically significant" set of data for any one revision. The following charts include all of the available pretest-posttest data for the most recent revision of Unit I.

Figure 1 shows the pretest and posttest scores for the individual operators who have thus far completed the current version of Unit I.

We scored our tests like true-false tests; namely % right - % wrong/4. Using this scoring system, a student who merely *guessed* on the test should have scored 37.5. Some operators actually scored *below* 37.5 on the pretest. The maximum possible score was 100, the minimum was minus 25.

The chart shows that the posttest score was better than the pretest score for each operator. The *range* of posttest scores was not as wide as the range of pretest scores. Thus, the program tends to bring all of the operators up to a common level. This is a characteristic of the programs. The levelling action helps to make up for deficiencies in the operators' backgrounds.

Background data at the bottom of the chart indicates that there was little correlation between education, experience, and test scores, except that the high-scoring operators were all Class B. (We haven't tried the program out on any Class A operators.)

Figures 2 and 3 summarize the pretest and posttest scores. Both charts follow the expected "bell-shaped" curve. As expected, the posttest bell is shifted to the right.

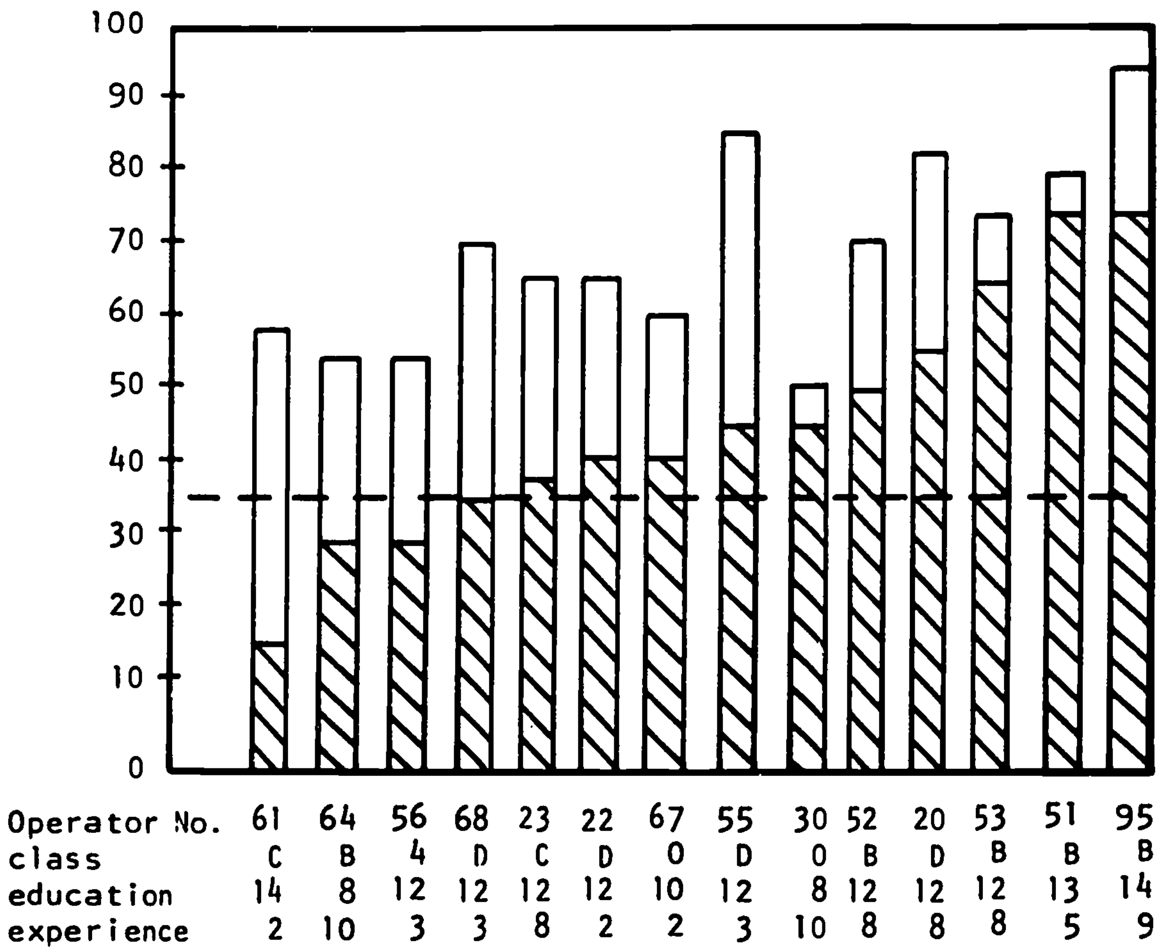

Figure 1. Pretest and posttest scores for each operator individually.

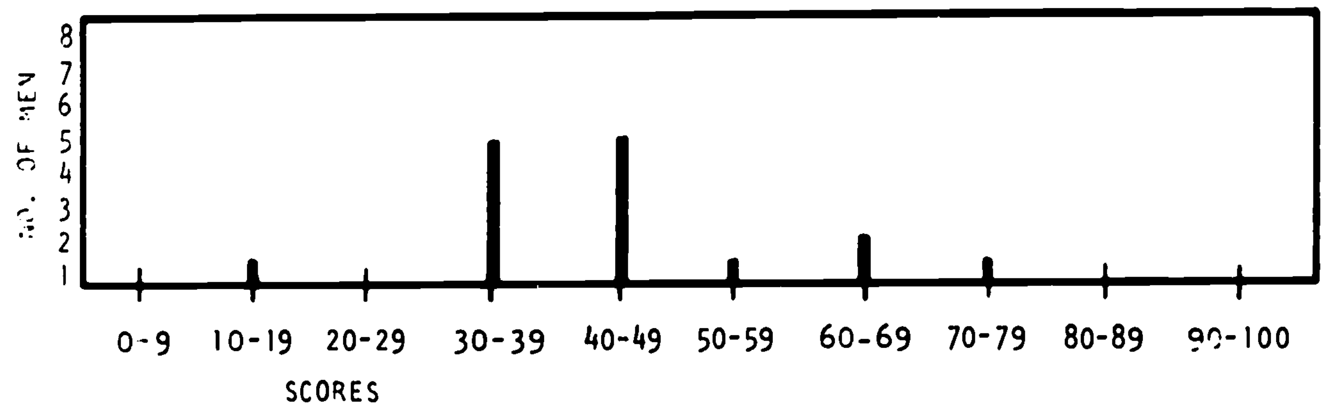

Figure 2. Summary of Pretest Scores

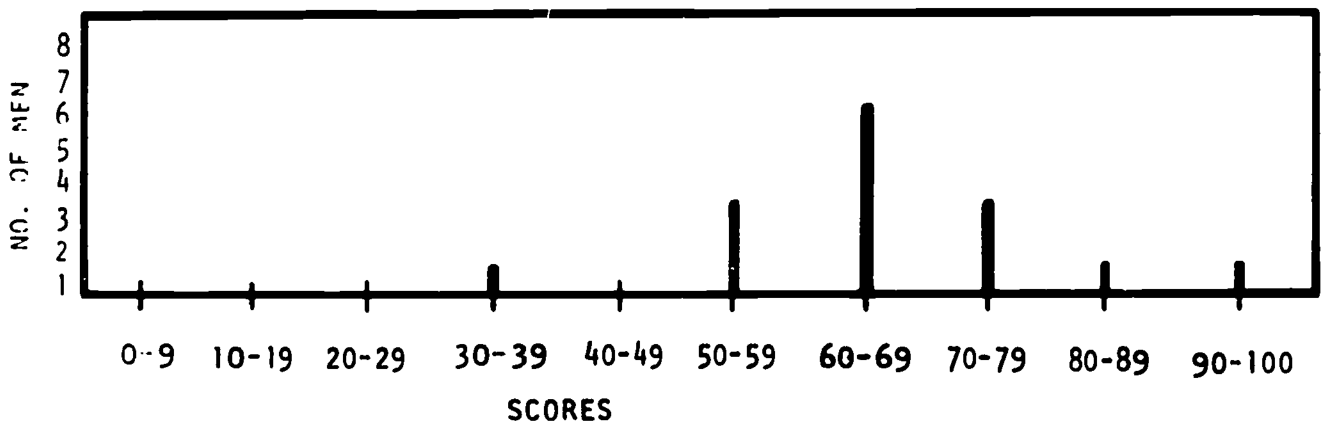

Figure 3. Summary of Posttest Scores

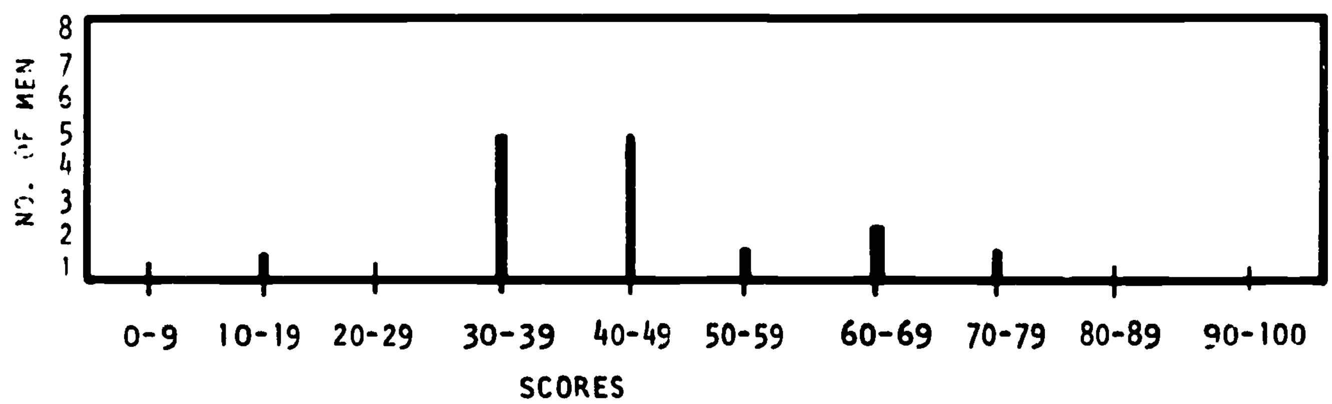

Figure 4. Improvement Scores

In order to compensate for differences in prior knowledge, we have set up an "improvement score", as follows:

$$\text{Improvement} = \frac{\text{Posttest - Pretest}}{\text{100 - Pretest}} \times 100$$

Since 100 is the maximum test score, "100-pretest" indicates the amount of material the operator *did not know* on the pretest. The "posttest-pretest" figure tells how much he *learned*. The improvement score is thus an indication of the percentage he learned out of the total amount he *could have* learned.

We have been considering any improvement score over 35% as satisfactory. A score of 35% means that the student picked up over a third of the information that he didn't know, in one pass through the unit. Very few lectures can do as well.

A summary of the Improvement Scores for the current version of Unit I is given in Figure 4.

In addition to statistics, we have been collecting comments from the operators and the reviewers. The comments should serve as an indication of the acceptability of the program. We have tried to sort out the favorable and unfavorable comments. The following table summarizes the results.

	Operators		Reviewers	
	Favorable	Unfavorable	Favorable	Unfavorable
Unit I	26	15	13	6
Unit II	13	9	5	2
Unit III	2	--	1	--

CONCLUSIONS

Figure 4 and our collection of comments should indicate why we are fairly well satisfied with Unit I. There are still a few rough spots in it, but on the whole it has accomplished its purpose, and we plan to publish it in the near future.

Considerable work remains to be done on the later units in the series, but we feel that the problems in them can be overcome as the evaluation proceeds.

The results of our work appear to show that programmed instruction *can* be applied successfully to the problem of upgrading treatment plant operators.

ACKNOWLEDGEMENT

The preparation of our programmed instructional materials, and their evaluation, have been supported in part by Demonstration Project WP139 from the Federal Water Pollution Control Administration.

ERIC

EDUCATIONAL TECHNOLOGY

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Of course, it is indeed a pleasure to be here with you today. I have to disillusion you, to begin with, by stating the fact that what I have to say to you today really isn't about mass media, although that might be included. I have taken a liberty which I hope you will permit me; namely, I looked over the very comprehensive program that you have and marveled at the completeness with which this conference covers the whole area of training and institutional technology and the various facets that will be covered. And the presumption I'm going to make as I see how completely topics are covered otherwise, is to philosophize with you about some of the good and bad aspects of training to talk about some of the nitty-gritty aspects of trying to put into effect, some of the ideas that you will have been exposed to during this conference. As a matter of fact, to be completely honest with you, I was very fortunate in being able to have lunch with one of your colleagues and took the opportunity to pump

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him for a great deal of information about what you fellows do; where you live, -- I mean where you live professionally -- where you work day-by-day. I was trying to get a keen sense of how this whole area of Manpower Training, vis-a-vis instructional technology, really interfaces with your life. And that luncheon, as I told the gentleman at the time, has appreciably altered what I had planned to cover with you. I know, having been to conferences of this sort before, that sometimes the ideas which are presented seem perfectly logical; they seem valid; you'd like to take them back home and apply them. That will be feasible in some of your situations. In other situations, where there's only you and a very small staff, and most particularly a limited amount of money, you will wonder what you're going to do with all this information; how you're going to make it practical; how you're going to put it into effect. I don't know that I can offer you any panacea this afternoon, but I would like to, at least, point some directions that might be practical and which, through concerted effort, you can take advantage of. I'll attempt to describe what instructional technology has to offer to meet your nitty-gritty, guts-level daily life needs. In this connection, you'll find my remarks rather more generalized than directed to your particular occupation -- and, I hope, with justification, because I find it extremely difficult to separate the problems of "operator training" and the kind of training which occurs in an elementary school or that which occurs in college, or that which occurs in Manpower Development Training. And this is more than a point in passing that I'm trying to make. A basic concept has to be, or a basic starting point has to be, that we are trying to *modify* human beings, that we are dealing with human perceivers and human learners. It's really kind of incidental, at least in the context in which I'm talking, whether they're fifth grade kids, or your operators, or college students, or whatever, because the kind of principles with which I assume this conference is concerned, and the kind of principles to which you have been exposed, really, when stripped of the particular application to your occupations, deal with some very basic ideas about how human beings, whomever, wherever they are, see, perceive, think, learn, and thus are modified. That theme, I hope, will be underlying everything else that I have yet to say this afternoon.

Let me also be presumptious enough to give you an answer and then explore what the question was. I think that the real answer, and maybe its simplicity, will deny its importance, the real answer to your needs in manpower training development, is that in order to take advantage of instructional technology -- and I shall enumerate these advantages subsequently -- we have to quit dissipating our dollars in duplicating efforts, unnecessarily, over and over again in every county, in every state throughout the nation. Now I am perfectly aware of the great spectrum of skills and abilities which you people bring to the job and that you have to contend with. And I am perfectly aware of the spectrum of skills in which it is your responsibility to train people. In consequence of that awareness, I am perfectly aware of the difficulties of trying to make any kind of feasible "fit" of your instructional efforts to this great heterogeneity that you find in people, and in skills which must be acquired. But I'd like to make another assumption here -- the assumption is that there are a finite number of differences among people with whom you have to work, and there are a finite and identifiable number of kinds of skills which are your responsibility to develop, and that as long as these two dimensions are finite, they can be managed extremely well and more efficiently by instructional technology than usually is the case.

I'd like to ask you to follow two tracks in your own mind during the remainder of what I have to say. That's a difficult thing to ask, and will probably militate against some of the very principles which I'm going to talk about, but I have a purpose in mind. I want you, on the one hand, to follow me in terms of the points that are made and the principles that are discussed; in other words, the presentation itself. However, simultaneously, I'd like for you to keep asking yourself this kind of question which will be clarified and given substance as we talk about instructional technology and media applications. Moment by moment, as I make a point, present a concept, explore a problem; ask yourself the question, "Is this really the way you ought to be learning at this moment? Is this the most efficient way to do it? Is it the most effective way?" Ask if you will be most effectively modified because it was this experience; namely, me standing up here lecturing to you? Or at any one point in this lecture would it have been accomplished better by group discussion? Or film? Or a field experience of some kind? Or an on-the-job experience? Or through some of the learning techniques that you have been discussing already. Or, on and on -- it's not my purpose now to catalogue all of the media options that you can make. I am talking against my own presence here. But you must come to the conclusion, any number of times during my presentation, that this is hardly the best way to be accomplishing our common objectives and goals of the moment. The point of my comment is not at all to criticize this conference. I'm talking about modes of instruction and their relationship to achieving the aims of training and education. All right, I said I would be presumptious enough to give you the answer and then explore what some of the questions were. The answer was to quit the duplication of training efforts that I alluded to a moment ago; to insist that organizations be formed so that you can identify your training needs. And instead of training being a new problem to be solved by individuals every place, and with extremely limited resources in most cases, that you develop what -- I don't know what term you would choose to use -- some national curricula which will identify and address itself to basic operational skills which you must teach. There're a lot of dimensions to this kind of solution which I would like to explore. The logic is simple: that if you have to take "X" number of dollars (if we could somehow tabulate the number of training dollars available to *all* of you sitting in this room) if they are spent for many of you to duplicate each other's efforts to devise and conduct your own training programs, obviously you're going to have limited dollars. And obviously when you ask the question: what should I be doing at this moment of instruction, should it be film? Should it be a field experience? Should it be some kind of manipulative skills? Should it be the use of a mock-up, or whatever? Your answer is going to be "well, that's great, but I don't have the money to build a mock-up. How in the world can I undertake to develop programmed learning material? Computer assisted instruction is quite beyond any hopes in my training program, with my few dollars." But if you *combine* those few dollars they become many, and it becomes feasible to develop instructional materials for computer-assisted instruction, and programmed learning texts, and materials for teaching machines, and for educational television programs to reach people in the shop, or to reach them at home perhaps, or in tech centers, or whatever happens to be the situation where you work -- it becomes feasible to do that. So there's a solution to the dollar problem inherent in taking this kind of approach, this cooperative collaborative approach; forming consortions among you to develop the training material. But it's not just the dollar aspect, one can argue just as favorably on the side of improvement of instruction. And again, I'll use myself as my own worst example. All of you perfectly well understand some of the words that I just used. Or, depending upon the extent to which you've had an opportunity to delve into learning technology, you may or may not be so conversant with them, may or may not know what's involved in developing program learning materials, or developing computer-assisted instruction, or what constitutes really good television instruction, in terms of conceiving the program, in terms of producing the programs, in terms of presenting them, in terms of combining "utilization" with those programs. I'm sure you differ greatly among you in terms of the extent to which these are familiar topics. The point that I want to make is: I stood up here and I just used words didn't I, and they communicated more or less well, *depending upon* your individual background. But, I can assure you that if I could take you one by one, take each individual, I could assess whether that was a very effective approach, then, having made that kind of assessment, I could identify a much more effective instructional approach. You see, I can argue that at least a very major answer to the training question is seeing to it that the cooperative production of instructional materials is undertaken by your national organizations, or the organizations to which you belong, or those which you generate yourself, or even through a multiple state pact. I can assure you that this is one effective answer to the problem. Now let's go back for a few minutes, if I may, and explore why I'm concerned today with a great deal more than just mass media. If you want to make the most simple statement of what *your* job is all about as a training director, it is, in my opinion, *your job is moving experiences to learners.* That's what you're doing. You're moving experiences to learners. Sometimes you move learners to experiences, as in on-the-job training. But within the context of this conference, we're concerned with the use of media, and the application of media to instruction -- what that's all about is *moving experiences to learners.* I can define the role of technology in two simple statements. *It enables you to control information, and it enables you to control the behavior of learners.* And now we come to the heart of what I consider to be my presentation today. Having made an initial suggestion of how we can answer the training resources question, I've then tried to address myself to the question of what's it all about. In simple terms it is to move experiences to learners, and do it in such a way that we control information and we control behavior. That's it. Now the rest is elaboration. First, some aspects of controlling information. And you'll see the relevance of these remarks, as I said in the opening, much beyond your occupation, much beyond your professional concern, to encompass your kids in school, to encompass American education in general. If one is really honest about any classroom at the elementary, secondary, or college level, most training in the services, training in industry and business, and so forth, we would have to admit something like this. This stream of information which I'm imparting to you today will range, depending upon you as an individual or as a group, from highly suitable to being highly unsuitable, from being highly comprehensible, to being highly uncomprehensible, from being highly relevant, tc being highly nonrelevant, to your needs and moments. Isn't it a flaw in the training effort for me to assume any time I appear before a group, that there's homogeneity among learners, that there's some common level at which I can present my information? "*Control*" information in terms of "A"-content and "B"-level -- and the way in which the content is presented. The net result of assuming homogeniety among learners is that the cost-effectiveness and general efficiency of an instructional process conducted largely without media, or only by illustrated lectures (which sometimes give the illusion of using media) is that the learning return is minimal per man hour invested. So now we get another element into this business of controlling information because there're two aspects to that -- controlling information in terms of the *presenting mode*, whether that's a computer, or a human being, or a film, or whatever. But controlling information in terms of the learner himself making a fit between the needs of a learner, that fit in two ways, the needs of the learner and the content of the presentation, and the capability of the learner, and the method of approaching, the method of reaching in form, instructing the learner -- this can only be done with instructional technology. The control of information and an instructional system and an instructional setup requires, first of all, that you know what information to present and not as determined by some superior knowledge of a curriculum committee, though that may be a useful part of the process too, but a system which will allow you to have some very firm directions in terms of what content to select, but, most importantly, of the thing that I have not touched upon yet, and that is this matter of selecting the appropriate mode for the instructional objective of the moment. OK, now having made the point I want to jump back to the answer again. You notice that inherent in all of this I'm saying is that if you have a limited budget and a small staff you're not going to devise instructional systems, it's not likely that you're going to devise instructional systems that are of the kind of sophistication of which your previous speakers have been talking. And the containing ingredients that I'm alluding to now just aren't. There's only one way that you're going to do it and that is basically change your concept of yourself to be managers of learning. But a great deal of the curriculum development of the job training materials could be developed on a national and/or regional basis. Now, another point that I haven't touched on, which is certainly not a digression, is the whole area of resistance on the part of training directors themselves and instructors to the use of instructional technology. And I must make a few points on that because anything else that I would say would be useless, unless there is a real committment on the part of training directors and on the part of their instructional staff to redefine their jobs and retrain themselves very often. You know many of the shibboleths and I certainly will not attempt to catalogue nor discuss them all. But I suspect in some ways, what I'm about to say, if I don't make an awful lot of people mad before I leave this platform today, I'll not have accomplished my mission. So you'll excuse the candor that I'm about to allow myself. This is a pretty sophisticated area, and in order to really be responsible for designing or setting up instructional systems that maximally use instructional technology one must be extremely well-grounded in many aspects of human psychology and perception, human learning, learning theory, the results of learning research, communications theory, the results of communications research, and have a certain adequacy in the hardware aspect itself. Many people, having found different avenues to their job, don't have this background; subconsciously or not, they feel threatened. On the one hand, they very often give assent -- Oh, that's a very good idea. I can see it would be effective in a valid way of instruction, but that's where the whole thing breaks down. But, the fear here, I suggest, very often, if one can conceive of himself as a manager of learning, is really unwarranted. It's not ordinarily, or should not be in the kinds of instructional systems which I'm talking about, the training director's job, except in very large systems which have multiple departments and so forth. But in the ordinary case it's not the training director's job to devise instructional systems. He's a manager of learning. So are instructors managers of learning, but designers of very sophisticated constructional systems. But once you get over that hurdle you see, or once you start conceiving of yourself as manager of learning, then it's not so hard to swallow that it is possible to identify basic skills very often, and it isn't unique in this county, and this county, and this county. And this is denying that there are different problems in different locales, but there are basic operational skills in any job, and that there are basic attitudenal areas that need to be developed, and so forth. Once one conceives of himself as a manager, generally it's rather then that one is more ready to conceive that instructional materials can be developed elsewhere, that it is possible for curricula to be developed; it certainly would involve people like him, being involved in the design process. And it is assumed that in the process of devising these materials, they'll not be designed in the abstract, up here some place, but the people will look at the requirements in the field. And that touches upon a topic that I haven't mentioned yet -- I didn't really see it in the program -- and that is the area of defining instructional objectives in terms of work for behavior. Has that been touched on really? All right, I see you shaking your head. OK. One of the surest ways that your concerns will be taken into account is that in the proper design of your training materials, they, instructional objectives, will be defined in behavioral terms -- what your operators, what your workers, what people that you have to train actually do. So that here again a kind of specter that often raises it's head, that specter that somehow these materials are going to be designed by some guy or guys out of touch with reality as I live in it, should not turn out to be the case. Because in order to design instructional systems in behavioral terms you've got to go find out what people do; you have to make a task analysis first. But notice how much easier one's job becomes when these resources are pooled in the way that I'm talking about, and notice how much more effective the educational process can be. That's part of what makes one's job easier. I said about the control of information -- I haven't talked about the control of behavior yet -- but as I elaborate the point on the control of behavior what we're going to be talking about is that instruction becomes more effective. Because I know exactly what the instructional process was like, I'm able to take the instructional process and see, in fact, if it was effective, and if it wasn't, revise it. And this, whether I'm talking about instructional television, or devising a film, or complicated interrelationships of instructional media, or whatever. Like today, using myself as my own worst guinea pig. Do I even have the remotest idea of how you as an individual might have been modified when I leave this platform? It's sheer speculation on my part. Sheer speculation on my part, and I'm willing to say that about myself because, although it's no comfort, I can say the same thing about what occurs in most training situations, 98 percent of the training situations. Except in those instances in which there is job performance we have some gross data eventually that the guy either can or cannot perform his job. But if he can't where did we go wrong? Now where in this lecture and in this demonstration, and in this on-the-job training process, where did we mess up? So really it's illusory that we know something about the effectiveness of our training procedures in that instance, isn't it? Just because the guy cannot do the job we don't know what either did or did not enable him to acquire those skills. So effectiveness also has its relationship to cost effectiveness, doesn't it? Per limited dollar that is apt to be available to us we can devise instruction which will enable us to do the things that we should be doing and can do best, and to reallocate our time for jobs that take face-to-face relationship and particular kinds of contact and so forth, and know with fair assurance what the outcome of the instructional process is going to be. Because once we go about devising in all the ways that you have already been told in a conference -- and there certainly would be no need for me to repeat -- once you go about finding instructional objectives, behaviorly, and systematically trying to allocate the instructional task to the proper instructional medium, and so forth, you can make some pretty fair predictions if you know the entry behavior of the worker or the trainee. If you know the capabilities of the instructional materials or system, you can make some pretty fair predictions in terms of what the outcome is going to be. I haven't said much about control of behavior, which is another element that you accomplish by pooling your resources and enabling yourself to devise instructional material systematically. At any one point in this lecture there may be one of you that I happen to hit a particularly responsive cord. And had there been just you and me, and I'd been able to follow that up while you were highly motivated while exactly the right questions came to mind, while those few remaining misunderstandings were there, this would have been an extremely beneficial exchange. But there was no behavioral control there. If you were excited about something perhaps it's already vanished. If there was something misunderstood, then I have built upon that misunderstanding. And again I'm willing to admit that about myself because that's what happens in most training programs. That's what's happening to your kids this afternoon in their schoolrooms. Suppose you were even so advantaged to have your kids in a class of twelve. But most parents that I know of would take great comfort in that. They would rather assume that their kids are getting some very special training or special educational advantage. Maybe they are and maybe they aren't. There is no way to know point-by-point what's happening to the learner. And when the teacher takes that gross estimate at the end of the day it was even that or at the end of some particular study period. And more often in our cases, not until the guy goes on the job or some intermediary periods in a training program, do we know. We don't know where to direct his behavior. Even with the kinds of performance and/or written test that we give him, we have such gross information as to how to retrain him, and notice when I say retrain I mean within the context of what he didn't learn within the learning process.

Well, I don't mean to reiterate all the things that I know previous speakers have told you as I look at the program. But I go back, and I want to conclude and leave a few minutes giving you some opportunity to shoot questions, disagree, or whatever is your pleasure, with some of the things I've said. But you look at the dollar situation, and this is not to be crass; this is simply to be practical.

You look at the dollar situation. I know some of your states well enough; I know what the dollar figure is for your training programs; I know what your staffs are. You're not going to be able to take advantage on your own of any developing instructional materials to any extent and certainly not integrated instructional systems of any sophistication. What is your hope then? Notice that parenthetically I am granting myself the premise that the goal is desirable, and granted that premise, what are your hopes? *Well there just ain't no other way fellows*, except by either getting through your proper Federal agencies support to develop instructional materials of a kind that you cannot develop for yourself but which you can manage, or to form consortiums among yourselves and pool your dollars. If it somehow can be worked out in terms of state regulations, and so forth, devise these instructional materials yourself. The goal is not only more effective training for the worker but a lot easier job for yourself. I conclude on what must be the most practical note of all. One of you gentlemen that I was talking about was telling me about being faced with the prospect in the not too distant future of having to hire but more likely, since he doesn't know exactly where he's going to find them, to train 75 operators, 75 people in your field, and he admitted he didn't know what he was going to do. He didn't really know what he was going to do and this certainly is not a statement that in any way says anything about a shortcoming of his. Is it? The people aren't there. He doesn't have the resources to train them. Now what is he going to do? What would you do in that situation? Unless you come from a very large metropolitan area and you're a very fat cat you're going to be in the same situation. Where would you turn for the kind of materials which would at least do a major portion of the job? Now unless I have been misinformed about your field -- and if I am, then my whole argument is shot down -- unless I have been badly misinformed the materials aren't there. The Department of the Interior has made no substantial committment to manpower development, and if it even did make some substantial contribution and it went along the lines of many Federal programs of simply passing out money to the States, it still wouldn't accomplish the kind of thing I'm talking about. Where does this man turn to train those 75 workers? Well, I know where he could train for them to solve a major part of his burden. If, as a group, you would commit yourself today to define what your training needs are, and define commonality among you, and identify the kinds of skill that are subject, particularly subject to being handled by media or multi-media, and, then would pool your resources, both major problems which you face would be well advanced towards solution -- namely, upgrading the personnel that you have and training the personnel that you do not have but need. Well, I hope this hasn't been too far a departure from the announced topic. But I work in a nitty-gritty world myself and ultimately as a director of an organization as with you. I've got to come up with solutions. I've got to produce something, people. And I hope that I have not been inappropriate in allowing myself the luxury to come here and suggest with all the fervor that I can suggest that you consider banding together and undertaking the kind of solution which I have suggested.

CASE HISTORY OF VIDEOTAPE PRODUCTION

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INTRODUCTION

Many full time employees at work sites remote from a university campus have a need for instruction in highly technical coursework. Because of the distance involved, their full time employment status, the unavailability of an instructor, or the inconvenience of attending class at a time when a course might be telecast on an open circuit, these individuals do not receive the technical instruction they need.

Many students attending two-year institutions of higher education cannot obtain the coursework they need for transfer purposes, and subsequently are found deficient in credit when they transfer to a four-year institution.

With the support of Federal[1] and State grants, Colorado State University has initiated two instructional programs for students at remote campus sites. The two programs are entitled Project SURGE (an acronym for State

[1]Projects partially funded by the National Science Foundation, Grants GZ-753 and GY 53055.

University Research in Graduate Education) and Project CO-TIE (an acronym for Cooperation via Televised Instruction in Education). Both programs involve the delivery of video-tapes of live campus classes to remote classroom sites for subsequent playback to students enrolled for course credit. Both programs also involve special telephone networks and blackboard by wire equipment.

It is the purpose of this presentation to describe the details of these two programs and to report some of the evidence about their effectiveness.

BACKGROUND, PROJECT SURGE

In 1967, the College of Engineering at Colorado State University, with the cooperation of seven industrial firms in the State, initiated project Colorado SURGE. The primary function of project SURGE is to provide advanced and graduate level courses in engineering and related sciences to employees of Colorado industry. One of the regular engineering classrooms at Colorado State University was equipped with television cameras and monitors, thus permitting the live lecture situation to be recorded on videotape. The video-tapes for four engineering courses were then sent via courier to the seven locations, where students at the firms viewed the videotapes two days after they were recorded on the campus. Since the beginning of project SURGE with four classes and 190 off-campus students, the project has had

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unusual growth so that in the fall of 1969, 22 courses were offered to almost 400 employees at 17 industrial locations.

Through project SURGE, based on the use of videotape, the University has been able to redefine its campus boundaries so as to include every industrial location in the state of Colorado. Explained with detail in a following section, each of the SURGE courses is controlled by a lecturer on the Colorado State University campus. The instructor provides all the lectures, assigns homework and term papers and oversees all examinations and assigns a final course mark to the industrial student in the course. No distinction is made between the SURGE student and the campus student, so the industrial employees may earn regular university (resident) credit.

BACKGROUND, PROJECT CO-TIE

After the first year's operation of project SURGE, CSU initiated a similar, but somewhat more far-reaching, program (CO-TIE) in conjunction with six of Colorado's junior colleges. In project CO-TIE, engineering courses are videotaped in a live classroom on the CSU campus. The tapes are then delivered to participating colleges and viewed by the college students as part of their normal program. In 1969, as a result of project CO-TIE, students from the junior colleges are entering Colorado State University and other universities as fully qualified third year (junior) engineering students.

FACILITIES

All SURGE and CO-TIE classes originate from two specially equipped studio-classrooms located in the Engineering College at Colorado State University. The videotapes are recorded in the central recording facility of the Office of Educational Media located in a different building. In the initial programs, considerable care has been taken to preserve a natural classroom atmosphere by having all videotapes produced in a regularly-scheduled class of CSU students who are taking the course as a part of their degree program. Student discussion is encouraged while making the videotapes to provide the off-campus student with a feeling of participation in real system of education and, to a large extent, eliminate the idea that the programs are "canned."

Each classroom, seating approximately 30 students, is equipped with three cameras, any one of which can be switched on-line from the instructor's desk (Figure 1). Camera One, mounted at the back of the classroom is used primarily for instructor exposure and demonstrations (Figure 2). Tilt, pan, zoom and focus on this unit are controlled from the central recording facility by a TV technician (Figure 3). Camera Two, the overhead unit, mounted directly above the

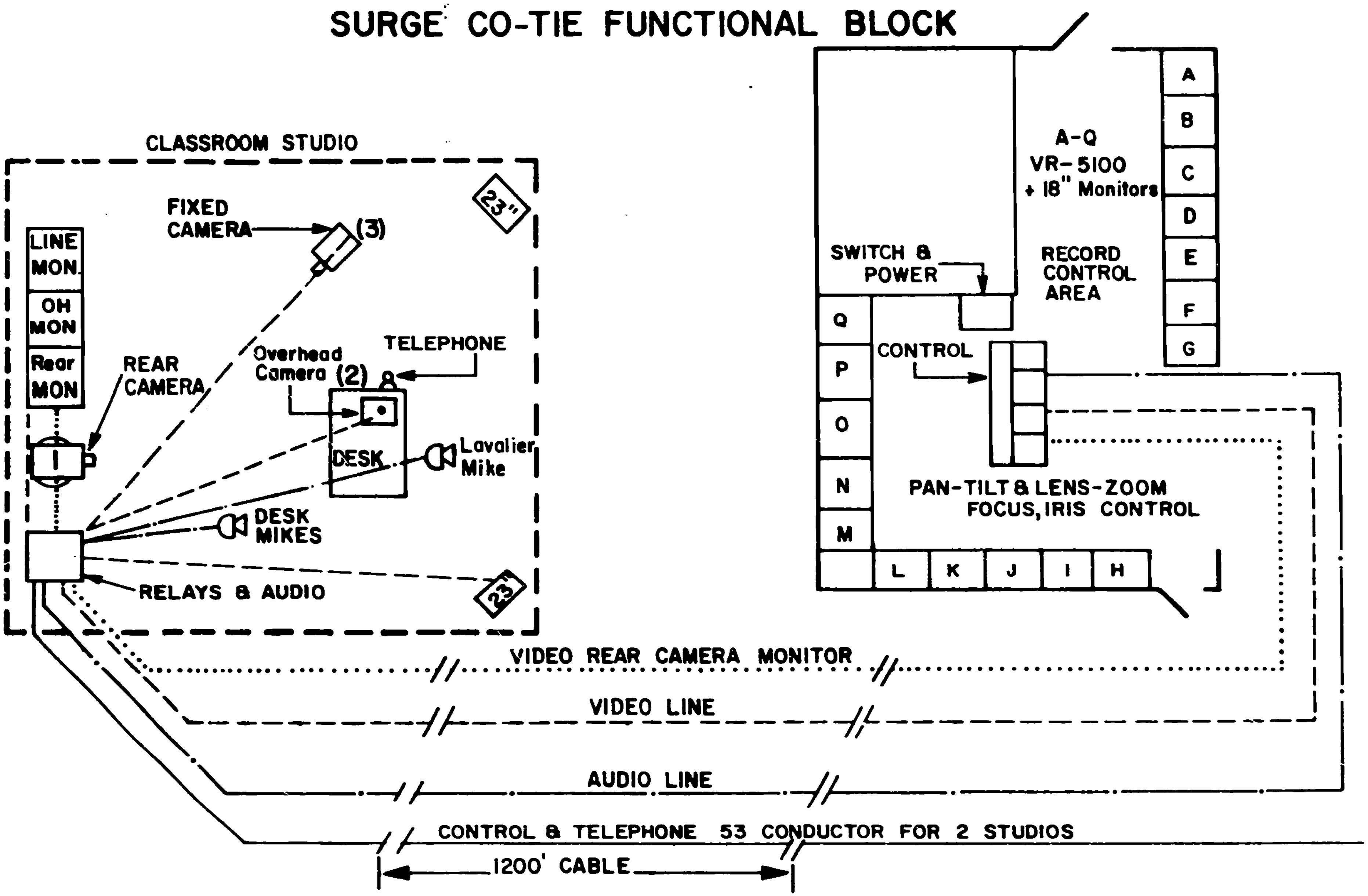


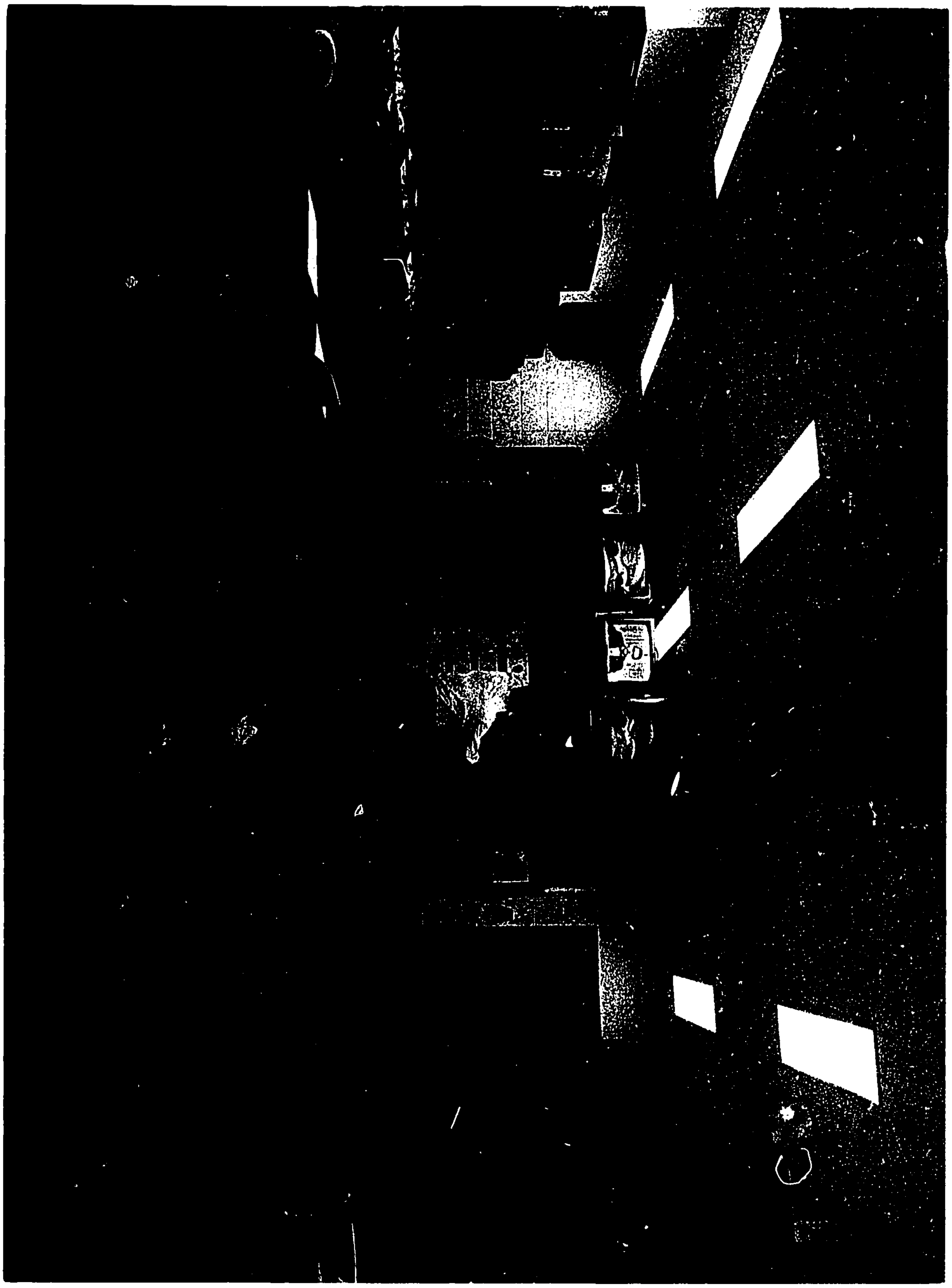
FIGURE 1. SYSTEM BLOCK DIAGRAM

FIGURE 2.

FIGURE 3.

instructor's desk, provides an alternative form of lecture presentation in that the instructor can show prepared notes and diagrams. Thirty-five mm. slides can also be presented via the overhead camera. The slide projector is located under the instructor's desk and focuses onto an opaque screen directly below the overhead camera. Iris, focus and zoom controls are operated by the instructor. Camera Three, a fixed-focus unit, is located at the front of the classroom for use when faculty-student dialogue occurs. Future plans call for a split screen capability which, among other things, will enable the instructor and questioning student to be recorded simultaneously. For control purposes, three monitors are located at the back of the classroom, facing the instructor's desk, (Figure 4), showing the "on-line" camera, the back camera and the overhead camera. Two additional on-line monitors are located at the front of the classroom for student viewing. Audio communication is via a lapel microphone for the instructor and switched desk microphones for the students.

The central recording facility at CSU is under the direction of the Office of Educational Media, a service department primarily concerned with the recording and distribution of audio-visual materials. Up to 18 video-tapes can be recorded simultaneously from the two studio-classrooms for distribution to CO-TIE and/or SURGE participants (Figure 5). Distribution is normally by parcel post or courier.



After playback at the remote locations the videotapes are returned to CSU, erased and stored for future use. This procedure is followed primarily because of the changing nature of the course material. Using these facilities approximately 350 videotapes were produced per week during the 1968/69 academic year for distribution to CO-TIE and SURGE participants.

Recitation and tutorial sessions are held for CO-TIE participants on a regularly-scheduled basis via the dedicated telephone network shown in Figure 6. Two-way audio communication is available for questions and answers. Considerable use is also made of an electro-mechanical writing system located at CSU for transmitting graphic information onto the monitors at the remote locations. During the Summer of 1969, slow-scan television also was used between CSU and Northeastern Junior College, Sterling, Colorado, for the transmission of graphic information (Figure 7).

PROJECT COLORADO SURGE

During the fall quarter, 22 courses are being videotaped for SURGE participants. The number of industrial employees enrolled in the program is slightly less than 400. The courses orginate in the Departments of Electrical Engineering, Mechanical and Industrial Engineering, Civil Engineering, Atmospheric Science, Mathematics, Physics, Business, and Psychology, and are offered to students

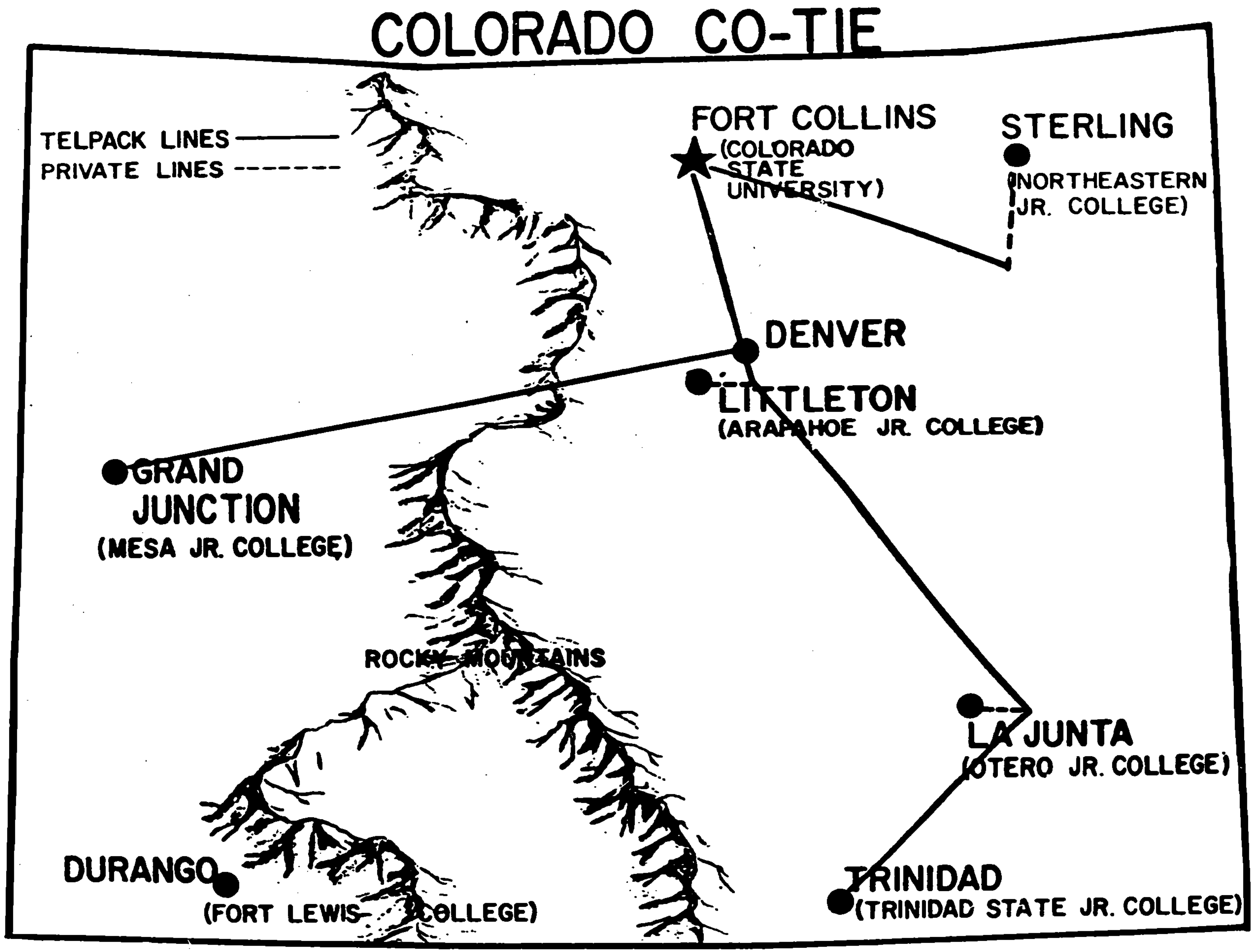


Figure 7

CO-TIE TELEPHONE NETWORK

on campus who attend class in the studio-classroom while the videotapes are being recorded. The questions of the "live" students are recorded on the videotapes via microphones located on the students' desks. Recording the questions of the "live" student reduces much of the need for instructor/off-campus-student dialogue since the "live" students ask most of the questions which would arise from the students in the remote locations. As soon as a class has been recorded, the videotape is delivered via courier (an armored car service) to the industrial locations and viewed by the industrial students within two days. Class notes, assignments and examinations are delivered to the industrial firms with each videotape. After the assigned work is completed by the student, it is returned via the courier to the instructor. Contact between professor and student is maintained by occasional telephone calls to the campus. Twice each quarter, the professor visits each of his off-campus classes just prior to the examinations to conduct detailed discussion and review sessions.

At each industrial firm there are two persons appointed by the industry and by Colorado State University to oversee the in-plant operations. One person is the Educational Officer, usually the Director of Personnel, whose duties are to coordinate all operational details of the program; e.g., videotape reception and mailing, book ordering, publicity for the program, student registration and scheduling of courses. In addition, there is a senior engineer or scientist appointed by Colorado State University as a faculty affiliate to a particular academic department who oversees all academic matters with regard to the program at the industrial location. The faculty affiliate maintains close liaison with course instructors and serves a major role in maintaining an academic environment in the remote classrooms. With the consent of the CSU instructor, he will monitor examinations, collect homework and advise participating students.

The central philosophy of the SURGE program is that full control of a particular course remains with the instructor in that course. All lectures, assignments and examinations are originated and the results judged by the Colorado State University instructor. For this reason, the University treats the SURGE courses in the same manner as resident (on-campus) courses. In other words, a student who successfully completes a SURGE course receives credit on his transcript as though he were a student on the campus at CSU.

PROJECT COLORADO CO-TIE

Project Colorado CO-TIE was initiated in September, 1968, with the following objectives:

1. To provide college students with all the key courses necessary for transfer to a four-year university engineering program.

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2. To provide the opportunity for advanced work to faculty and staff at participating institutions by taking graduate level SURGE courses.

3. To provide the vehicle for cooperation in such matters as curricula development, laboratory design, transfer agreements and facility sharing.

During the first year's operation, 56 off-campus college students were enrolled in the CO-TIE program primarily to study the sophomore level electric networks sequence, although courses in fluid mechanics and computer programming were also available. The electric networks courses constitute the pre-engineering sequence with which CO-TIE is most concerned since this area was found to be the weakest at the majority of colleges in Colorado.

Project CO-TIE does not seek to usurp the role of the colleges in any way, but strongly encourages the college faculty to improve their own curricula by participating in the program. Faculty at the participating colleges will take courses in vocational education teacher training as well as a special in-service mathematics seminar under the CO-TIE concept.

Of the 56 off-campus students taking part in the CO-TIE project, some 25 were pre-engineering students, the remainder being registered in terminal technology programs. Approximately 24 of the pre-engineering students have transferred to four-year engineering programs at universities as fully qualified juniors (3rd year students).

The operation of project CO-TIE is very similar to that of SURGE except that (1) regular tutorial periods are held for the off-campus students via the telephone system shown in Figure 6, (2) course grades are given by the students' college and not by CSU and (3) a college faculty member usually from the Science or Engineering Department serves as coordinator for the project.

EVALUATION OF THE PROJECTS

As an integral part of the first year's operation, both Project SURGE and Project CO-TIE were evaluated by the Human Factors Research Laboratory of Colorado State University. Complete reports from these evaluations are available through inter-library loan, Morgan Library, Colorado State University, or from the National Science Foundation. In the evaluations, both intellective and nonintellective factors were assessed.

In Project SURGE, it was found that the industrial students performed equally well when compared with their campus counterparts. Their attitudes toward method of instruction and toward course content were more favorable than those of the campus students, however,

In Project CO-TIE, it was found that the on-campus students excelled the college participants in achievement, but that their attitudes were considerably less favorable.

The evaluations were based on 432 industry enrollments and 192 campus enrollments for Project SURGE, and 56 college student enrollments and 389 university enrollments in Project CO-TIE.

COSTS

Detailed costs for the capital outlay involved in Projects SURGE and CO-TIE have been maintained as well as detailed operating costs on an annual basis for the two-year experience with Project SURGE and the one-year experience with Project CO-TIE.

Capital outlay necessary to equip the two studio classrooms in which the instruction on the Colorado State University campus is recorded was $13,200 for the two classrooms, or $6,600 per individual room. Capital outlay for the central recording facility, including 18 video recorders, 18 monitors and a switcher with 12 inputs and 12 outputs was $41,320. Capital outlay for 300 1" videotapes (one-hour reels) and 100 shipping cartons totaled $18,500. Cost of the blackboard-by-wire system was $6,850. Playback classroom equipment costs in the remote classrooms totaled $2,410 per classroom. Facility cost for the remote blackboard-by-wire equipment was $4,000 per setting. These expenditures yielded a total of $79,870 for CSU, $2,410 for each participating SURGE plant, and $6,410 for each participating college.

The annual operating costs for the two programs are as follows:

Personnel	
Three technician-cameramen	$19,500
Student labor	4,000
Videotape delivery	10,000
Videotape replacement	12,500
Telephone	16,000
Total Operating Costs	$62,000

The foregoing figures do not include costs of engineering design, construction, space rental, and installation of equipment.

SUMMARY

Based on the experience of Colorado State University, the use of courier-delivered videotapes for providing technical instruction at remote sites offers promise for use in many situations. In addition to the relatively low cost of providing such instruction via videotape, the method offers maximum flexibility to students in remote settings. Classes can be held at any convenient time, and videotapes can be shown more than once, held over, or retained permanently for instructional purposes. Evaluation data support the use of this method as a satisfactory instructional medium.

COMPUTER-BASED EDUCATION

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In a time when computer technology is being applied to all areas of endeavor, it is appropriate that it should be investigated as a method of relieving the problems and pressures in the educational market place. The University of Illinois has been experimenting with a computer-based education system (PLATO--Programmed Logic for Automatic Teaching Operations) for the past eight years. This system has evolved from a single terminal connected to the Illiac I (a medium speed computer built in 1954) to a central laboratory classroom and four remote classrooms of graphic-pictorial terminals connected to a Control Data Corporation 1604 computer. This research into the potential role of the computer in education has constituted the first of two phases of the development of PLATO. The second phase, that of applying this experience to the design and development of an economically viable large-scale computer-based education system, will be discussed later in the paper.

A student terminal on the PLATO system consists of a keyset and television monitor configuration as shown in Figure 1. Information viewed on the television screen is

EQUIPMENT DIAGRAM FOR PLATO

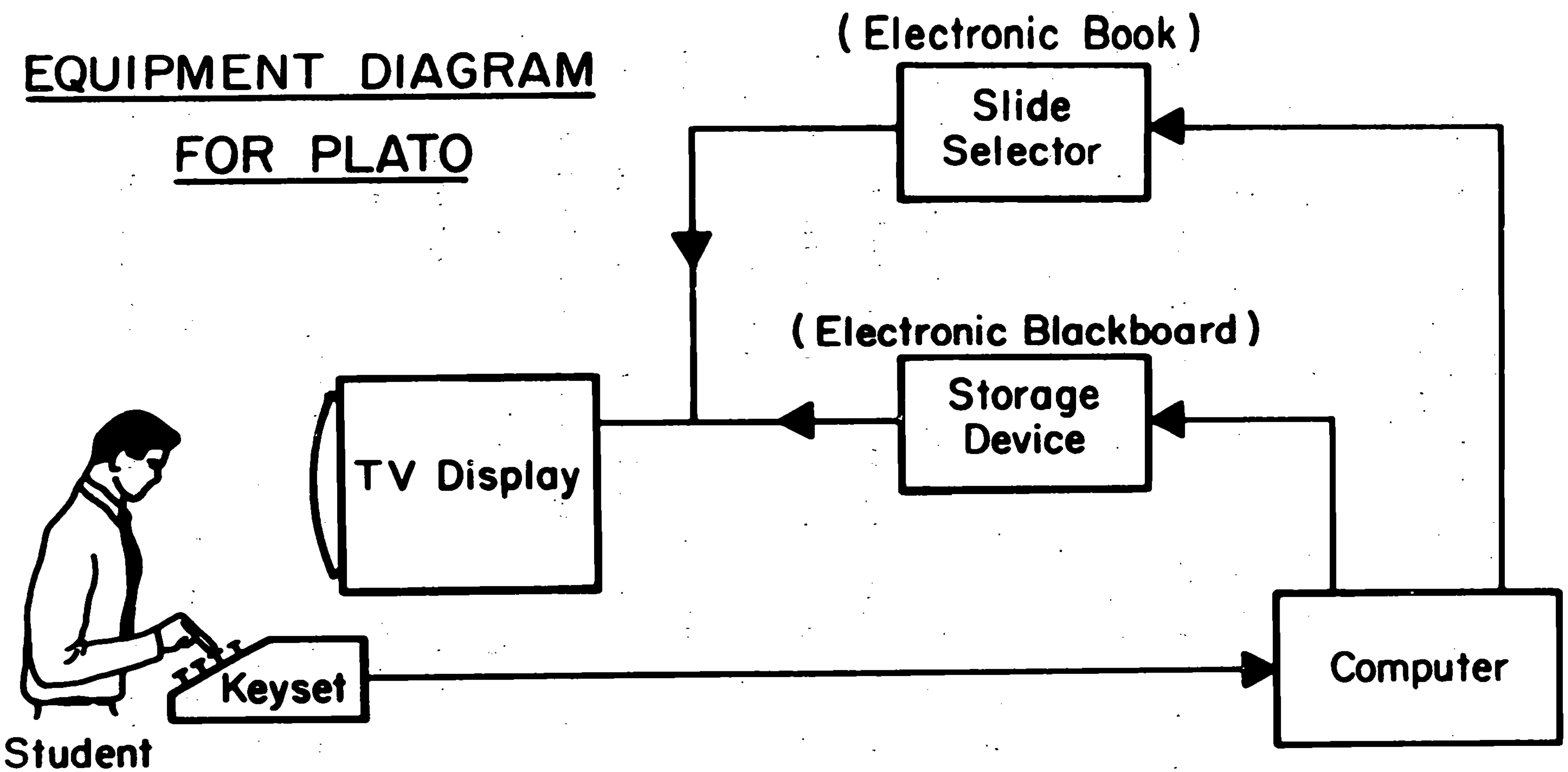

Figure 1

composed of slides selected by the computer (random-access time less than 1 millionth of a second) and superimposed images of graphs, diagrams, and alphanumeric characters drawn by the computer in a point-by-point fashion. The student uses the keyset for controlling his progress through the lesson, constructing answers, asking questions, and setting up simulated or real experiments. The computer responds to a student's requests within a tenth of a second (1).

The computer can also control additional devices which have been connected to a student's terminal, e.g., movie projectors, lights, audio devices, etc. Through the terminal, the computer can control and respond to apparatus associated with real experiments which are being performed, and it can administer training exercises using real equipment simulators connected to the terminal (2).

The present PLATO III system consists of one classroom of 20 terminals located at the Computer-based Education Research Laboratory--CERL (Site of the central 1604 computer and interface equipment) and four remotely-located classrooms. The remote classrooms are situated in four different institutions: a school of nursing, a community college, an elementary school, and the University of Illinois' School of Life Sciences. The first three sites each have 12 terminals, the fourth has 14; all of the terminals are connected to the PLATO III equipment at CERL via video and telephone communication lines, and all of the

ERIC

sites are controlled by the same central computer. Although only 20 terminals can be in operation simultaneously, the remote sites are providing additional facilities for expanded research into the educational aspects of a computer-based education system and supplying important information concerning the problems of remote site management and widespread public reaction to the system. They are also supplying information about student terminal data rates and related technical parameters.

This paper will discuss some applications of computer-based teaching. At the higher education level, there is a greater emphasis on the development of critical thinking skills than on the simple transfer of knowledge. To effect the development of critical thinking skills, an inquiry mode of teaching is utilized, involving the student in the solution of problems. The student must analyze the problem, gather and evaluate information and test his solution. The computer can give an immediate judgment of the student's response, providing positive reinforcement of a correct response, or guiding the student to a different solution in the case of an incorrect response. In our applications of computer-based teaching, we find that several unique features of the modern digital computer make it an ideal instructional device for developing cognitive skills. The computer can provide individualized instruction and immediate feedback; it can keep detailed records of the student's past performance, and it can provide remedial training by use of complex internal branching and the alteration of the presentation or the type of material based on the student's past performance (3).

The computational use of the computer appears in several ways. First, experiments can be simulated by the computer, thereby immediately providing the student with results he uniquely requested. These same results might require hours or even days to calculate by hand. Second, a large amount of computation is involved in processing student responses. The more flexible the format the student may use to answer a question, the more feedback needed to inform him of the correctness of his response. When only multiple choice responses are required, the processing is relatively simple. But when the student is permitted to construct long alphanumeric and graphic responses, the computer must analyze his answer to see if it is equivalent to a correct response, check for spelling and completeness of the answer, as well as inform him which part of an incorrect answer is unacceptable. Sequences taken from lessons presented on PLATO will illustrate the student-computer interaction. Among the areas in which research studies, course development, and teaching have been done are electrical engineering, geometry, chemistry, biology, nursing, library science, algebra, math drill, computer programming, and foreign languages (Russian, French, and

Latin). To present this spectrum of subject material, a variety of teaching strategies ranging from drill and practice to student-directed inquiry have been implemented through the use of powerful author languages.

One of these languages, TUTOR, a user's computer language consisting of more than 80 English directives to the computer, is being used to write lesson materials in a wide variety of disciplines for PLATO (4). It requires no prior knowledge of computer programming and is easily learned and used.

The lesson examples below from geometry and a study of the spread of an epidemic were written using TUTOR.

The geometry lessons were developed to give students an understanding of geometric concepts (5). A grid is provided on which the student draws and manipulates geometric figures. The computer is used to determine the correctness of the figure, independent of its size, location and orientation on the grid. The student must select points of the grid to be used as the vertices of his figure. To do this, eight keys on his keyset have been defined which move a bright spot around on the grid. (Figure 2 shows a diagram of these keys. The arrows on the keycaps indicate the direction in which the key jumps the bright spot on the grid.) Once a student has decided on a point, he communicates his selection to the computer by pressing the MARK key. He presses the

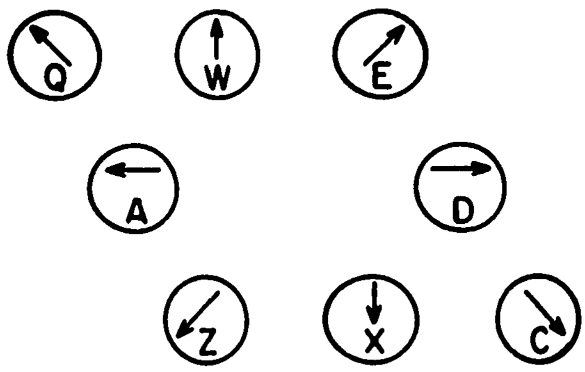

Figure 2

CLOSE key to close the figure (connect the first point to the last point). To judge the figure the student presses NEXT and the computer either okays the figure or indicates the student's error.

In the following sequence, the student is asked to draw quadrilaterals with a single line of symmetry. In Figure 3a the student is instructed to draw a quadrilateral with one line of symmetry: the two possibilities are an isosceles trapezoid and a kite. He selects the points he wishes to use for his figure and marks them. Figure 3b shows the partial construction of the trapezoid. When four points have been marked the student closes his figure and asks the computer to judge it. In Figure 3c, the completed figure is judged and the computer points out to the student that the symmetry line for an isosceles trapezoid does not go through the vertices.

The student then moves to the next page of the lessons and is asked to draw a quadrilateral with a single line of symmetry that does go through the vertices (Figure 3d). The student, however, reconstructs the trapezoid. The computer, when judging the figure, recognizes the duplication and tells the student that he has drawn the same figure as he drew before (Figure 3e). The student then draws a kite which has a single line of symmetry through vertices and the figure is judged "OK" (Figure 3f).

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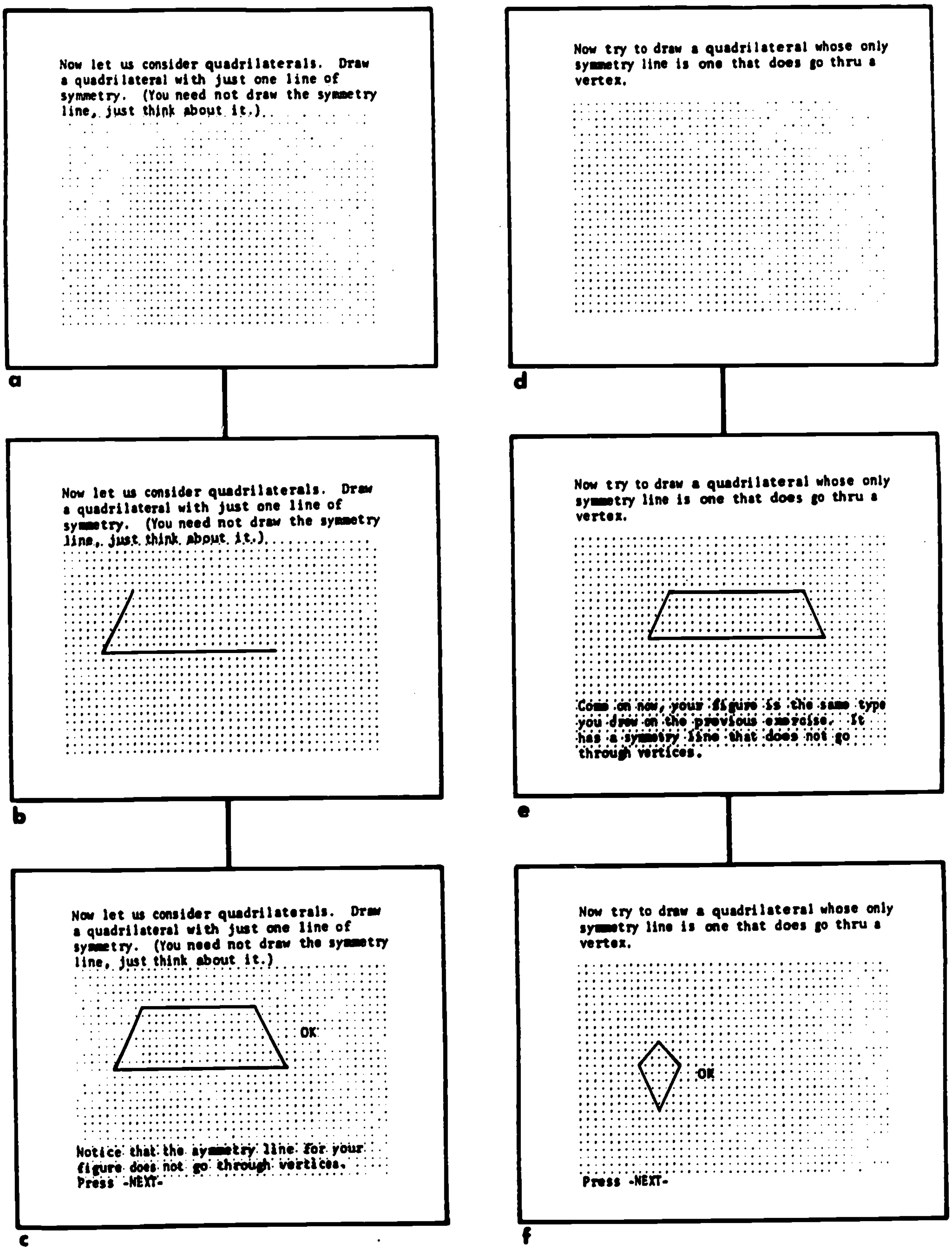
Now let us consider quadrilaterals. Draw a quadrilateral with just one line of symmetry. (You need not draw the symmetry line, just think about it.)
a
Now let us consider quadrilaterals. Draw a quadrilateral with just one line of symmetry. (You need not draw the symmetry line, just think about it.)
b
Now let us consider quadrilaterals. Draw a quadrilateral with just one line of symmetry. (You need not draw the symmetry line, just think about it.)
OK
Notice that the symmetry line for your figure does not go through vertices.
Press -NEXT-
c
Now try to draw a quadrilateral whose only symmetry line is one that does go thru a vertex.
d
Now try to draw a quadrilateral whose only symmetry line is one that does go thru a vertex.
Come on now, your figure is the same type you drew on the previous exercise. It has a symmetry line that does not go through vertices.
e
Now try to draw a quadrilateral whose only symmetry line is one that does go thru a vertex.
OK
Press -NEXT-
f

Figure 3a-f

In teaching of certain principles which involve an extensive amount of calculation, a student's use of the computer to calculate and plot his data permits more extensive analysis and understanding of the material. The second example is from a study of the spread of an epidemic. By manipulating the size of a population, the number of persons originally infected, the number originally immune, the rate of spread of the infection, and the rate of immunization, the student gains an intuitive feeling for the effects of the different variables upon the spread of a disease. The student observes a diagram of the relationship between the variables before specifying values for them (Figure 4). He can return to this model for study at any time by pressing DATA. He presses NEXT to begin specifying the parameters. He is shown the current values of the variable (they are initialized at zero) and may press NEXT to move the arrow to any he wishes to change (Figure 5a). Figure 5b shows the values the student has chosen to give each variable. When the student is satisfied with the values he has selected, he types the word "PLOT" to have the calculated values plotted (Figure 5c). In Figure 5d, the student may choose to have the curve plotted for immunization, for infection or for both. He selects number 3, the combination of the curves. Both curves are plotted as a function of time in Figure 5e. The student may change the variables and plot the respective curves as many times as he wishes until he understands the model.

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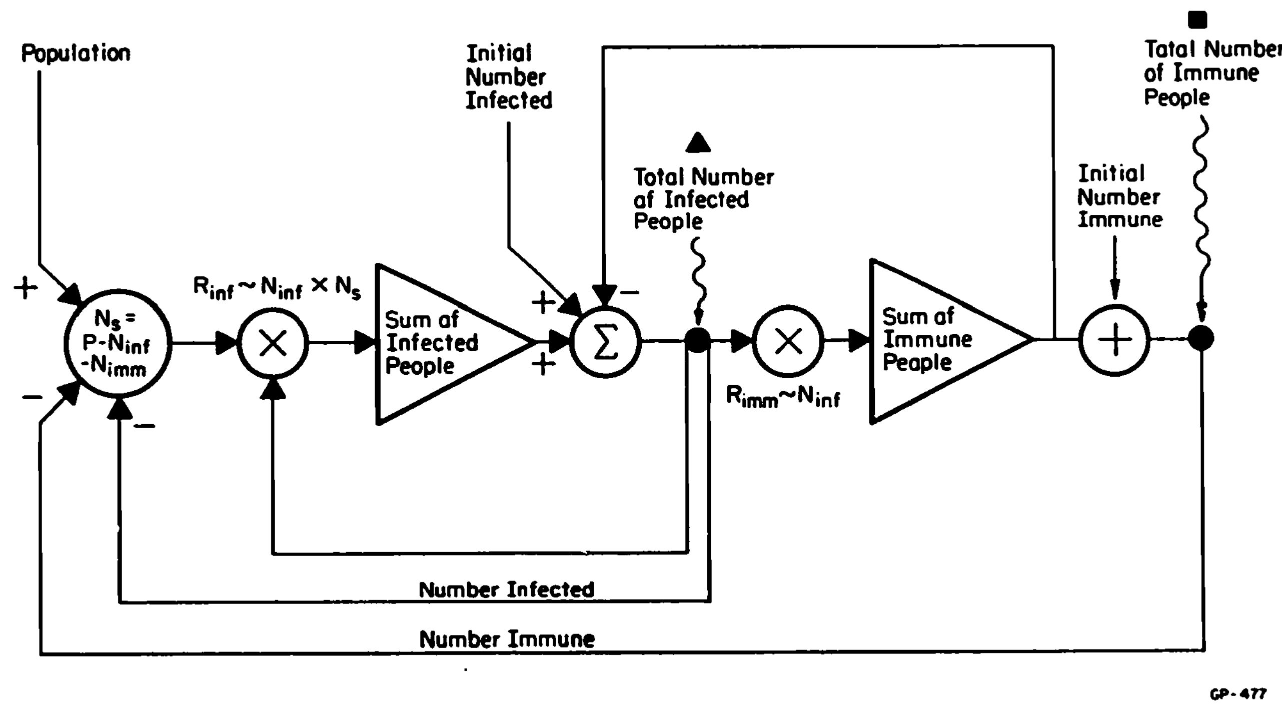

Population
Initial Number Infected
Total Number of Infected People
Initial Number Immune
Total Number of Immune People
$N_s = P - N_{inf} - N_{imm}$
$R_{inf} \sim N_{inf} \times N_s$
Sum of Infected People
$R_{imm} \sim N_{inf}$
Sum of Immune People
Number Infected
Number Immune
GP-477

Figure 4

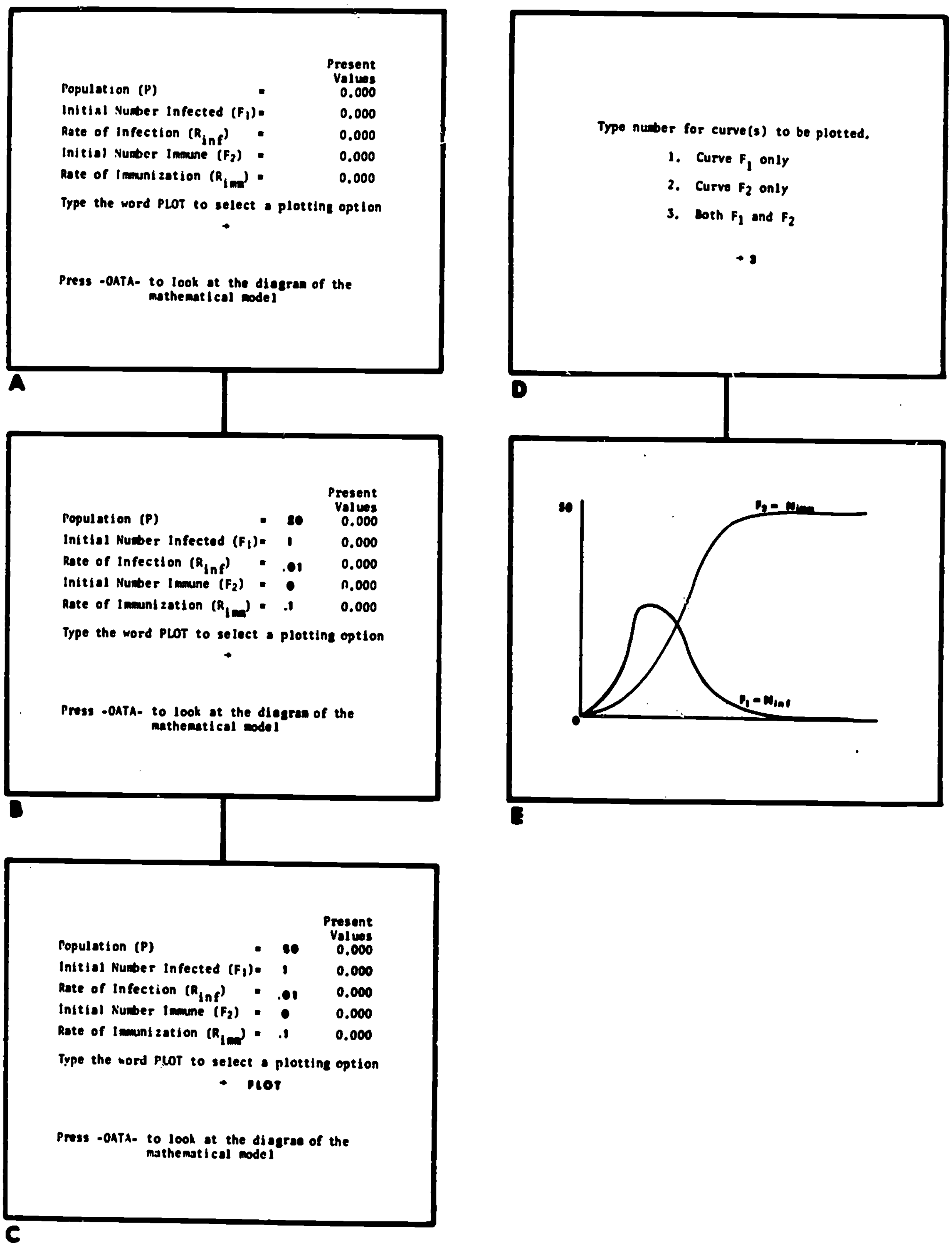

Present Values
Population (P) = 0.000
Initial Number Infected (F1)= 0.000
Rate of Infection (Rinf) = 0.000
Initial Number Immune (F2) = 0.000
Rate of Immunization (Rimm) = 0.000
Type the word PLOT to select a plotting option
Press -DATA- to look at the diagram of the mathematical model
A
Present Values
Population (P) = 50 0.000
Initial Number Infected (F1)= 1 0.000
Rate of Infection (Rinf) = .01 0.000
Initial Number Immune (F2) = 0 0.000
Rate of Immunization (Rimm) = .1 0.000
Type the word PLOT to select a plotting option
Press -DATA- to look at the diagram of the mathematical model
B
Present Values
Population (P) = 50 0.000
Initial Number Infected (F1)= 1 0.000
Rate of Infection (Rinf) = .01 0.000
Initial Number Immune (F2) = 0 0.000
Rate of Immunization (Rimm) = .1 0.000
Type the word PLOT to select a plotting option
PLOT
Press -DATA- to look at the diagram of the mathematical model
C
Type number for curve(s) to be plotted.
1. Curve F1 only
2. Curve F2 only
3. Both F1 and F2
3
D
50
F2 = Nimm
F1 = Ninf
0
E

Figure 5a-e

This sample sequence in economics is patterned on lesson materials developed in a maternity nursing course* and uses the General Logic (6), a powerful inquiry logic, to permit maximum flexibility for the student as he gathers and evaluates information. (This example of lesson material is not presently programmed on PLATO.) In Figure 6a, the student is asked to identify certain defining characteristics of elasticity of demand. To define "elasticity," the student presses the DICT key and is given a list of the words which are available in the Dictionary (Figure 6b). He types in the word to be defined and asks the computer for the answer, in response to which the computer defines the word elasticity as "response in quantity demanded which can be expected to result from a change in price" (Figure 6c). Having defined the word, the student moves to an Investigate mode by pressing the INVEST key and selects "Supply and demand analysis" from the simulated laboratory sequences available to him (Figure 6d). In Figure 6e, the student is given a choice of a variety of applications and experiments; he selects "D" for "point elasticity." Figure 6f shows the student a demand function, indicating the elasticity at various points on the curve. The relationship between slope of the function and the elasticity is explained. The student then

*Developed by Maryann Bitzer under a grant from the Dept. of Health, Education and Welfare. See Bibliography for publications.

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1.

2.

A

Investigate

Type the number of investigation desired ➧5

1. Graph functions
2. Sector analysis
3. Market structure
4. Total, average and marginal relationships
5. Supply and demand analysis
6. Mathematical proof of formulas

D

Dictionary

demand	price
derivative	sector analysis
diminishing marginal utility	slope
elasticity	supply
equilibrium	
indifference	
marginal revenue	
marginal rate of substitution	

Type in the word to be defined ➧ELASTICITY

B

Investigate

Supply and demand analysis

A. Cross elasticity of demand
B. Equilibrium
C. Elasticity (arc)
D. Elasticity (point)
E. Income effect
F. Slutsky theorem

Select area of investigation by typing corresponding letter ➧D

E

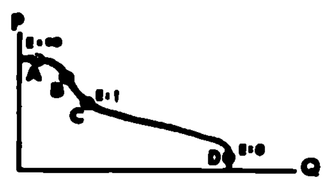
Dictionary

demand	price
derivative	sector analysis
diminishing marginal utility	slope
elasticity	supply
equilibrium	
indifference	
marginal revenue	
marginal rate of substitution	

Type in the word to be defined ➧ELASTICITY

RESPONSE IN QUANTITY DEMANDED WHICH CAN BE EXPECTED TO RESULT FROM A CHANGE IN PRICE

C

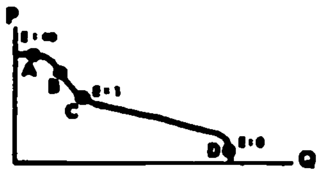


Point elasticity has the equation $-dQ/dP \cdot P/Q$. It should be noted that the derivative dQ/dP is the reciprocal of the slope of the demand curve, dP/dQ. The flatter the demand curve, the greater the elasticity.

To determine elasticity of a point on the demand curve, type the number of the point ➧A

F

Figure 6A-F



Point elasticity has the equation -dQ/dP · P/Q. It should be noted that the derivative dQ/dP is the reciprocal of the slope of the demand curve, dP/dQ. The flatter the demand curve, the greater the elasticity.

To determine elasticity of a point on the demand curve, type the number of the point ➔A

AT A, E=dQ/dP=dQ/0=∞. NOTE THAT THE SLOPE AND THE PROXIMITY OF THE POINT TO THE Y-AXIS DETERMINES THE ELASTICITY.

G

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION NC**

2.

H

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y**

2.

I

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y OK**

2.

J

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y OK**

2. **VALUE OF FUNCTION AT POINT OK**

K

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y OK**

2. **VALUE OF FUNCTION AT POINT OK**

DUPLICATE ANSWER

L

Figure 6o-l

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y**

2. **ANGLE OF FUNTION**

M

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y OK**

2. **~~ANGLE~~ OF FUNTION NO**

N

Certain characteristics of a point on a demand curve must be used in determining the elasticity of demand at that point. What are these characteristics?

1. **POSITION OF X AND Y OK**

2. **SLOPE OF FUNCTION OK**

O

Figure 6M-O

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requests that the elasticity of point "A" be determined. He is told that the elasticity at point "A" is infinite and that the slope and the location of the point determines its elasticity (Figure 6g). The student is now ready to return to the problem. Pressing the AHA key, the student is returned to the main problem. When the student types the answer "position," the computer indicates that the information is insufficient by "NC" (Not Complete). (Figure 6h).

In Figure 6i, the student expands his answer to read "position of x and y" and by pressing JUDGE, asks the computer to judge it; the computer tells him it is correct (Figure 6j).

In responding to the second question, the student has reworded the answer to read "value of function at point." The student is permitted to list the characteristics in any order, thus this rephrased answer is acceptable and the computer judges it as okay (Figure 6k). When the student presses NEXT to go to the next problem, however, the computer tells the student he has a duplicate answer (Figure 6l) and the student is not permitted to continue until he has two different characteristics listed.

In Figure 6m, the student tries a different answer, "angle of function" and in Figure 6n it is judge NO. The student is guided, however, by the fact that the incorrect portion of the answer (angle) is crossed out and the mispelled word (function) is underlined. When the student corrects this to read "slope of function," the computer judges the answer okay (Figure 6o).

Records of each student request (his identity, the key pushed, and the time to the nearest sixtieth of a second) is stored on magnetic tape. A complete re-run can be initiated by playing the record tape into the computer. These data are processed by the same computer that is used for teaching. Aprroximately fifty million student requests have been stored for processing. We have used these records for improving course content, designing better teaching strategies, and for planning a new, economically viable computer-based education system. In studies done at CERL, students have been given pre-tests, cognitive-style tests, and others to help in the evaluation of teaching on PLATO. Although there is insufficient data to draw educational conclusions, the PLATO students in almost every case score as well as or better than the classroom control groups on post-tests. In many cases, the time spent by the PLATO students is between 30 and 50 percent of the time spent covering the same material in the CERL classroom (7).

Experience with PLATO indicates that computer-based education has a wide range of application, from pre-school to post-college, from class-room utilization to continuing education for adults in remote locations. It has the potential for meeting currently unmet needs by supplementing the shortage of adequately prepared teachers in many fields, by providing effective job training in the face of changing technology, and continuing education for professional personnel (8).

Computer-based education will not meet these needs if it is not economical, however, Over the past decade, the cost per computer instruction has declined; the cost of terminals has not. The economic feasibility of computer-based education now rests upon the reduction of the cost of terminals and communication with the terminals.** Recognizing that the state of the art did not provide needed alternatives, engineers at the University of Illinois have developed a device, the plasma display panel (9), which combines the properties of memory, display, and high brightness in a simple structure of potentially inexpensive fabrication. In contrast to the commonly-used cathode ray tube display, on which images must be continually regenerated, the plasma display retains its own images and responds directly to the digital signals from the computer. This feature will reduce considerably the cost of communication distribution lines. Briefly, it consists of a thin glass panel structure containing a rectangular array of small gas cells (about 0.15 inches density of about 40 cells per inch -- see Figure 7). Any cell can be selectively

**Description of the new technology and economics taken from Reference 1.

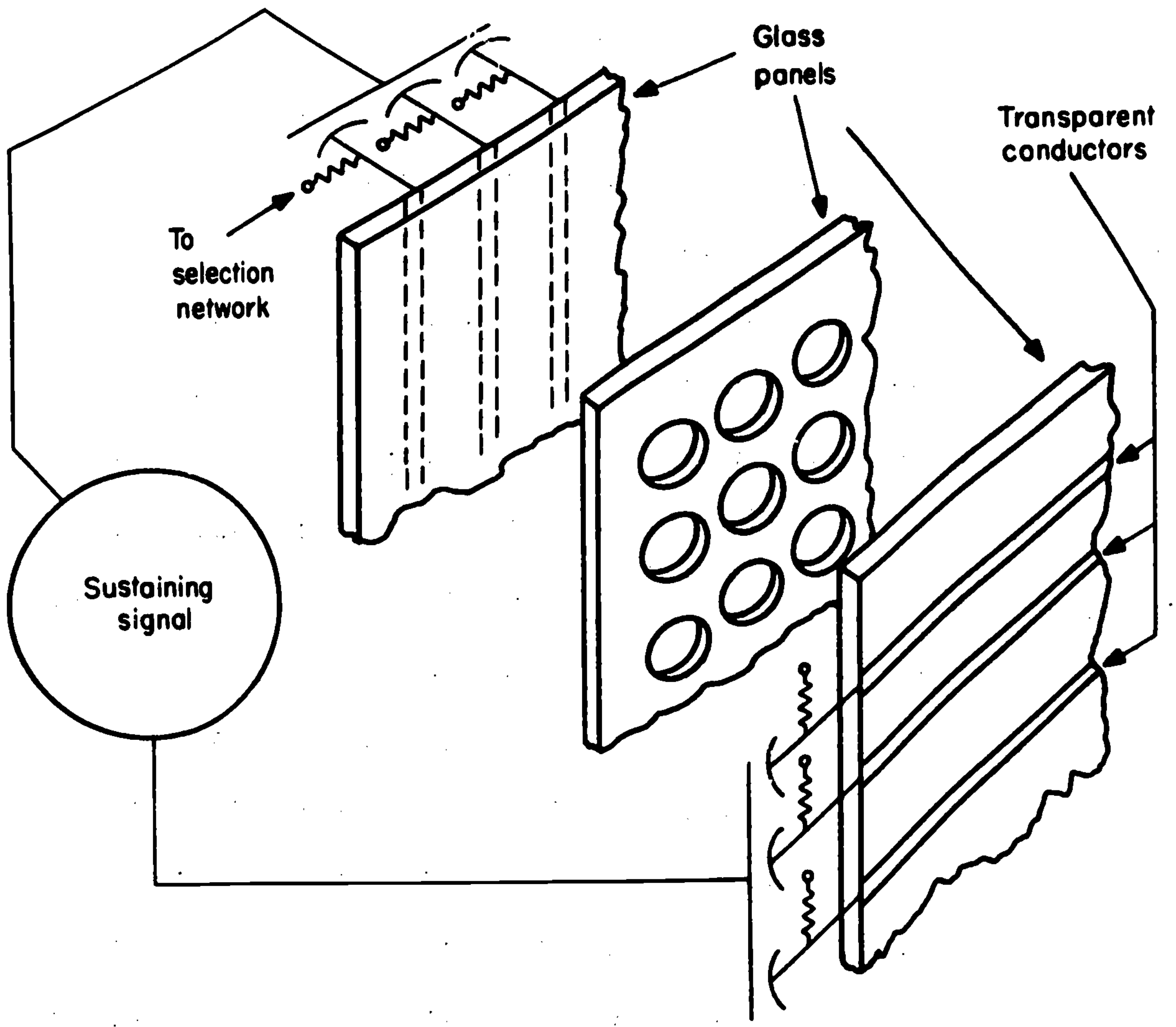
Glass
panels
Transparent
conductors
To
selection
network
Sustaining
signal

Figure 7

ignited (gas discharge turned on or turned off by proper application of voltages to the orthogonal grid structure without influencing the state of the remaining cells.) The plasma panel is transparent, allowing the superposition of optically projected images.

A random-access image selector is being developed at CERL for projecting color images on the rear of the glass display panel. The properties of this image projector include a 0.2 second random-access time on any of 256 color images, high positional accuracy, and low fabrication cost. The selector is a digitally addressable, pneumatically driven device containing a matrix of 256 images on a removable four inch square of film.

A prototype, random-access, audio recording and playback device has also been fabricated and tested at CERL. The device consists of an easily-loaded, inexpensive magnetic disc mounted on a turntable. Individual audio messages are recorded on the magnetic disc along given radii and in given azimuthal sectors. These messages can then be retrieved in a high speed (0.2 second), random-access manner. Satisfactory message capacities and audio fidelity are being achieved. Low fabrication and operation costs are again a major objective (10).

Figure 8 shows a drawing of the proposed student terminal incorporating the plasma display panel and the image selector. Data arriving from the computer via a

STUDENT TERMINAL

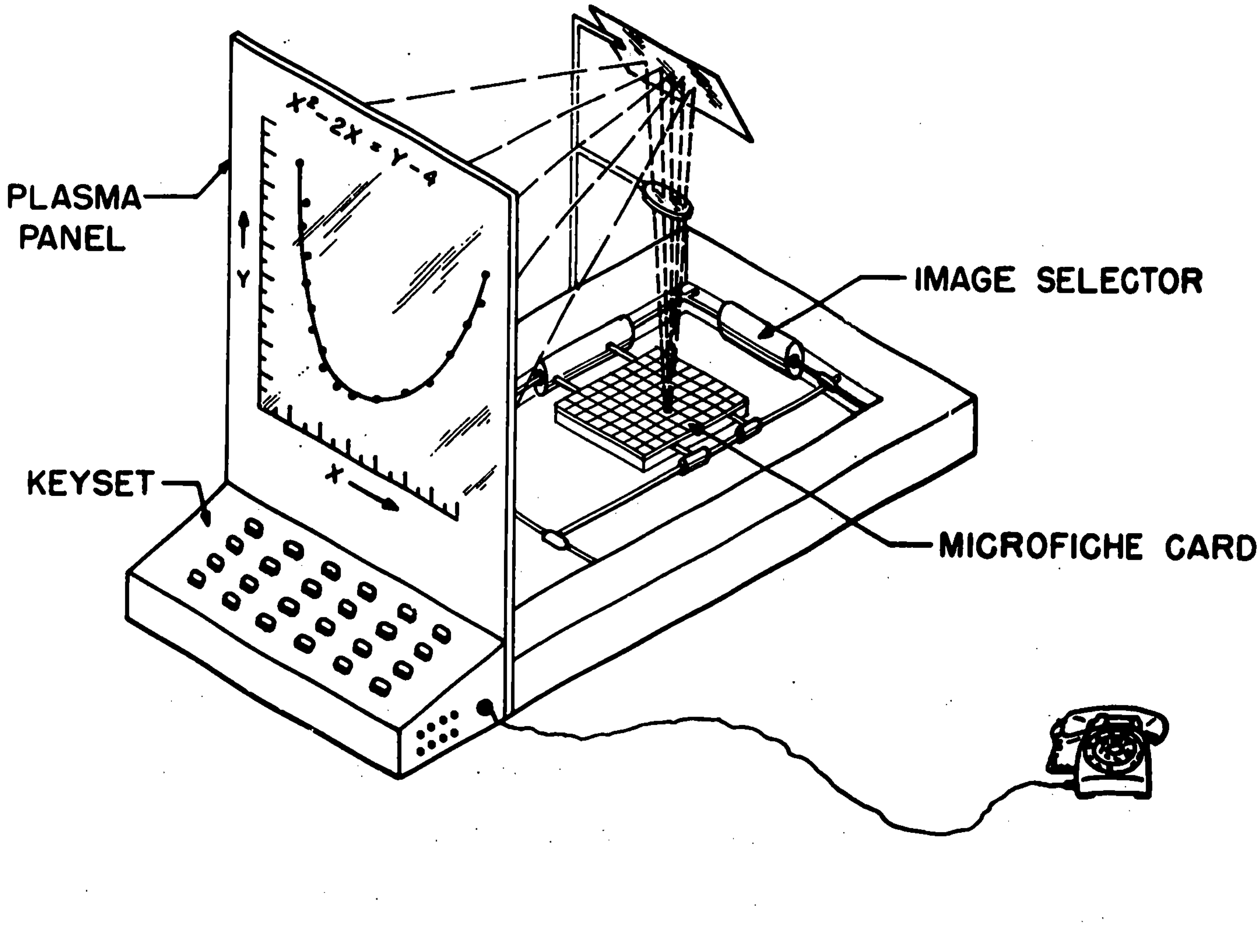

Figure 8

telephone line enters the terminal through an input register. Data rates to the terminal will be held to 1200 bits per second to permit transmission over standard voice-grade telephone lines.

In the situation where a large number of students are located at considerable distances from the central computer, costs can be lowered drastically by use of a coaxial line instead of numerous phone lines. Each TV channel can handle at least 1500 terminals on a time-shared basis, each terminal receiving 1200 bits per second. Data to remote locations will be transmitted by a coaxial line to a central point; from this point local telephone lines rented on a subscriber's service basis would transmit the proper channel to each student terminal. A block diagram of a proposed system for distribution to remote points is shown in Figure 9.

A computer mainframe which can handle 4000 graphic-pictorial terminals operating simultaneously, giving 1/10 second service to student requests, costs approximately $2.5 million. The cost of two million words of extended core memory to provide 500 words of unique storage for each of the 4000 students is approximately $2 million. An estimate for the system software, including some course development programming, is another $1.5 million. The total cost of $6 million amortized over the generally accepted period of 5 years yields $1.2 million per year.

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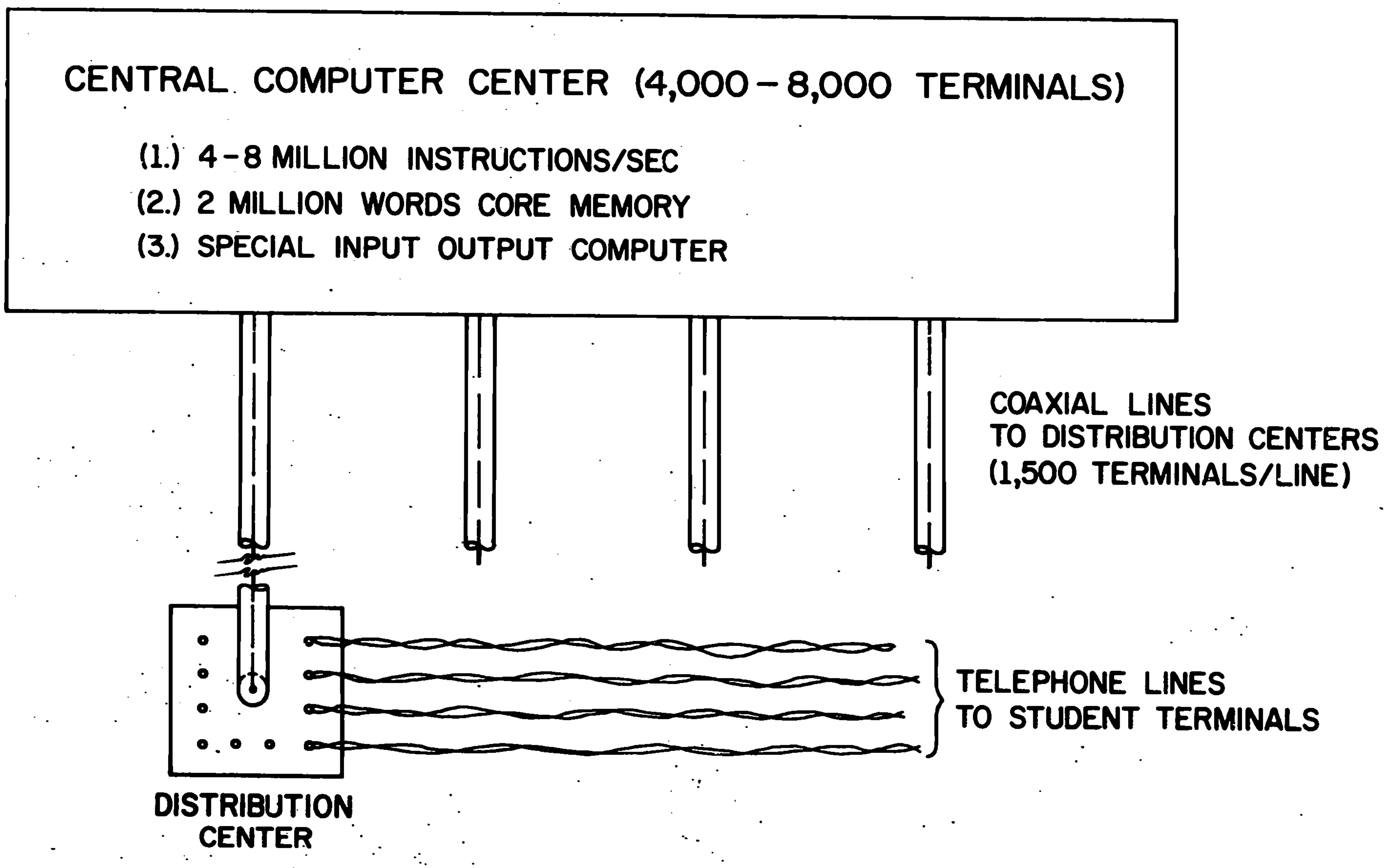
CENTRAL COMPUTER CENTER (4,000 – 8,000 TERMINALS)
(1.) 4 – 8 MILLION INSTRUCTIONS/SEC
(2.) 2 MILLION WORDS CORE MEMORY
(3.) SPECIAL INPUT OUTPUT COMPUTER
COAXIAL LINES
TO DISTRIBUTION CENTERS
(1,500 TERMINALS/LINE)
TELEPHONE LINES
TO STUDENT TERMINALS
DISTRIBUTION
CENTER

Figure 9

Assuming that the 4000 terminal system will be in use 8 hours a day for 300 days a year, there are approximately 10 million student contact hours per year. The system costs, excluding the terminals, is thus 12¢ per student contact hour. In order for the cost to be comparable to a conventional elementary school classroom cost of approximately 27¢ per student hour, the terminal costs must be limited to 15¢ per student contact hour, or to a total cost of about $7.5 million over a 5 year period. The cost for each of the 4000 terminals, which include a digitally-addressed graphical display device and its driver, an image selector, and a keyset must therefore be a maximum of $1900. Present indications are that this cost can be met.

The earning power of the computer for the remaining sixteen hours each day and for the idle time between student requests which would further reduce costs, has not been included.

Based on its extensive past experience with computer-based education systems and using newly developed technical devices discussed above, the Computer-based Education Research Laboratory is designing and developing an economically viable, large-scale computer controlled teaching system capable of serving 4000 multi-purpose terminals simultaneously. It is expected that the hardware and software components of the system will be implemented in definite stages, culminating in an operational system by 1974.

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ACKNOWLEDGEMENTS

The Computer-based Education Research Laboratory is supported by the following:

ONR Nonr 3985 (08) - Advanced Research Projects Agency

NSF GJ-81 - National Science Foundation

Metropolitan Museum of Art

Mercy Hospital Nursing Training - U. S. Health, Education and Welfare

U. S. Navy - University of Southern California Subcontract

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3. See Reference 1.

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SUMMARY AND EVALUATION

AN ENGINEER'S VIEW

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INTRODUCTION

As stated, the aim of the workshop was to focus on educational methods for training operators of pollution control facilities. To accomplish this aim, a diverse set of speakers and audience included representatives of educational media, educator, and user groups. It might be expected therefore, that interesting problems and questions would arise as the workshop progressed during discussion of factual information presented. Such was the case and further action was indicated in many areas of direct interest to the participants or their parent organizations.

The general tenor of the workshop breaks down into three major components. The first is concerned with the position and image of the operator. A second and more extensive area is identification and solution of the technical problems associated with operation of plants and operator training. Lastly, examination and discussion

ERIC

of needs and solutions pointed to current and future directions which should be emphasized to solve the operations problem.

POSITION OF THE OPERATOR

Discussion of operator status, pay and recognition was external to the objective of the workshop but was strongly emphasized during the early presentations and consideration of needs. It was apparent that low pay, together with a poor image, has a major impact on the recruitment, staffing, and education and training problems. Of importance is the fact that titling of operations personnel is uncertain along with the fact that terms such as *sewage* plant are not attractive. Associated with these aspects is an observed tendency for many operations personnel to downgrade themselves and their work and thus to further degenerate the status of their positions. Various causes have led to difficulty in convincing management, including elected officials, that operations and operators are important, that pay and skills must be raised, and that training is not only beneficial but necessary in most cases. These background problems have resulted in recruitment of many unskilled or undereducated persons, thus accentuating the necessity and diversity of the training task. This is particularly apparent in the small plants where only a few personnel are employed. It is apparently less severe in very large installations.

TECHNICAL PROBLEM

The technical problem of proper operation includes operator training. Provision of a proper training effort is made more difficult by the lack of common agreement among users on the definition of *operator* or associated personnel titles in plants, the definition of task and skill requirements along with levels, and their relation to size of treatment plant. Evaluation of the hierarchy of positions in plants to identify fundamental skills and responsibilities is needed as a base on which to build a better training effort. This must include establishment of standards so that training efforts can aim at attainment of a standard.

There are many diverse staffing patterns and associated different training efforts in the United States because of these uncertainties and the past lack of a national, coordinated effort in this field. That diverse training efforts exist is readily apparent when one considers the number of different training and operations manuals available, such as the New York and South Carolina manuals and the ones being prepared at Sacramento State, and, also when one examines the variety of short schools or other training methods employed in the states. To a large extent there is a lack of information among users on what others are doing in training, on materials available, and on the best way to train personnel. While diversity sometimes leads to important discoveries, this development in operator training appears to be uneconomical in approach and a hindrance to improved training. It undoubtedly developed due to the way in which pollution control has been attacked in the past. Current emphasis indicates that change is needed. One possible change would be to establish an information retrieval and dissemination system to inform others of the training materials, training programs, aids, and assistance available.

Training is progressing. The training programs described include improvement of multiple levels of operations personnel. From presentations and discussions at the workshop, it appears that three kinds of training would be advantageous in the future. One is management training. This is currently offered to some extent by the AWWA. A second is training of management personnel in training techniques. The third is training of plant operations personnel. The latter has been and is receiving the main emphasis, however, the other two types are also believed to be important. Perhaps efforts in these two areas should be expanded.

Since it is evident that operator training in the future should be standardized, improved, and increased, there are needs which must be satisfied in addition to those previously cited. Provision of texts and teaching aids, along with specification of suitable curricula, is a prime example. Stipulation of these elements is associated with identification of the task and skill requirements previously mentioned, and setting of standards. Increase in the number and better training of instructors to do the training are badly needed. This need extends from the junior college level to plant level since environmental technician or operator training is being accomplished in this range of educational effort. Emphasis should also be placed on *operations* at the senior and graduate engineering college levels both to assist in this training effort and to provide highly educated *operators* for the larger, more advanced, perhaps computer controlled, plants of the future. A systematic plan and attack on the instructor supply and training problem would appear to be indicated.

Associated with the instructional effort cited is a need to examine new educational methods and to develop and implement new methodology for training operations personnel. Presentations at the workshop included several examples of how new methodology may accelerate or improve education and training. Evaluation, development, and implementation should be accomplished in concert with solution of related problems of provision of instructors, instructor training, specification of curricula, texts, aids, and similar. A coordinated, planned, national attack is indicated as differentiated from states and local agencies proceeding independently.

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One problem associated with training of operators of small and intermediate sized plants requires attention. It was repeatedly mentioned that it was difficult to bring these operators to central places for attendance at short courses or other types of training. Thus particular attention must be given to a system to solve this problem. Possible solutions could include a mix of educational TV programs or computer aided instruction, correspondence courses, states providing a relief cadre of operators, traveling teams of training personnel, and similar. A great many treatment plants fall in this category. Therefore, it would seem that planning perhaps should segment the training problem and make separate provision for the different categories of plants. This appears to be only partially done at the present time. Associated with this is the alternative of governmental insistence on maximum combination of wastewater flows in an area so that proliferation of smaller plants is prevented. Enforcement of this policy would complement progress on solving the operator employment and training problems.

One last point is of importance. Certification of operators was mentioned several times. Certification is progressing in the United States and about one-half of the states have certification programs. A definite way to accelerate the training effort is for all states to adopt mandatory certification. Adoption places requirements on on public officials and management personnel to insure competent operation. Legal stipulations will serve as a spur to improvement in employment status and opportunities as well as to more and better training.

PRESENT AND FUTURE ACTIVITIES

The workshop at the WPCF meeting at Dallas in October, 1969 and the current workshop identified some common needs and suggested some current and future activities. Since change occurs slowly, management must continue to do its training job with the tools at its command now, whether these be short schools, correspondence courses, or other means. In the meantime, however, a national coordinated attack on the operations problem is indicated to improve this effort in the future. This coordinated approach should include a national inventory of the training efforts underway, and publication of results to the profession over the near term. This will insure that all are informed and help to prevent duplication of efforts. There also should be development of a national plan for training. This plan should include such things as defining titles, tasks, skills, and training needs, establishing recommended methodologies, and should present a planned program for meeting training requirements. Interaction of professional and technical societies, federal, state, and local governments, educators, and others will need to be provided for in accomplishing the

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evaluation, and establishing the plan and supporting programs. the objective should be to produce a training effort adequate in scope, operating in the most efficient manner, avoiding duplication, and making use of the best training methodology available. Whether these aspects should involve creation of additional national entities to accomplish them is uncertain. Of more importance is the *idea* that a coordinated, competent, planned continuing effort emerge in the future. This continuing effort should consider both the water and wastewater treatment plant operator training efforts together since there are many common features and, at state and local levels, many organizations are involved in both.

Associated with the national effort should be a concentrated attack on the *image* problem. Perhaps part of this can be solved through better definition of terms. A title of *Utilities* was suggested at the workshop for water and wastewater systems. Part of the national evaluation could include consideration of this aspect. It appears that the federal and state governments together with the professional societies could establish and promulgate standard nomenclature to be used in the future which would relieve some of the image problem and lead to improved status. Since this is a fundamental area of need, as indicated by the extensive workshop discussion, early action is indicated.

One other activity is suggested for the future. That is to expand the recruitment and public educational effort down into the younger age groups of society. With the importance of the environment and ecology becoming more apparent daily, a larger public awareness and understanding is necessary along with a greater professional input into the field. An effective way to attack this may be to offer interesting material and counseling down into the elementary schools. Here again, careful evaluation and planning are indicated. Visual aids would appear to be very beneficial. Consideration of this educational effort and establishment of programs should be part of the coordinated, national evaluation and planning previously discussed. Interim progress could be made through local emphasis by the professional societies and user groups.

SUMMARY AND EVALUATION
AN EDUCATIONAL TECHNOLOGIST'S VIEW

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The previous papers included in the conference proceedings have described the methods and techniques used by educational technologists to approach their problem of communication. Whether their particular medium happens to be a programmed textbook, a series of video tapes, a tape-slide program, or computer assisted instruction, the real guts of their efforts in developing instruction are found in the series of steps taken by each to achieve his objectives. We have decided to call the accumulation of these series of steps the *Process of Programming*.

Some of the Workshop participants may have found the models presented by Tiemann, Filep, Broadwell and Pursglove confusing; others may have found a common set of elements running through the models presented by each. Systems planning requires an awareness of many factors that influence the system itself. The systems planner might start by gathering information about both the audience and his task within the larger system. That information might include the competancies or performance that is required of the trainees upon the completion of an instructional unit. These competancies may be stated in terms of behavioral objectives. The objectives make it very easy to generate some criterion tests. Second, the systems planner might gather information about where the students are presently in regard to the goals that have been selected for instruction. From these bits of information the systems planner can determine what experiences need to be structured so that the trainees will emerge performing adequately.

Examine your instructional sequence in terms of its communications implications. Which parts can be done in large group presentations or demonstrations where the flow of information will be essentially one way? What types of performance will be achieved if the trainee is given materials and other facilities and permitted to study at his own rate without an instructor being present in the same room? And which kinds of performance can be achieved only if the instructor is paired with a small group of students or an individual where a two way flow of information is essential. Within each of these patterns one may look for media which can assist the task of presenting information or carry the entire burden of information for a selected instructional objective.

If one recognizes that media or teaching aids can be useful, the next task is to locate existing materials or

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to produce them yourself. The accomplishment of this step in the development of an instructional system would be greatly assisted by a handbook, an up-to-date handbook, listing all instructional materials available from a variety of sources which could be used to solve your training problems.

After a presentation is made, the systems planner would want to evaluate the efficiency and effectiveness of the system by asking students for some performance that will determine their achievement in performing selected tasks frequently done by an accomplished worker. Test makers tend to look at test results as a means of spreading students along a continuum so that students can be compared with one another. A systems planner is more concerned with using such data to improve his instruction and may try to identify, through a process called *item analysis of criterion items* the points where students are having trouble so that he might concentrate his attention on improving those parts of the instructional sequence. This information when used to improve the instructional sequence is called *feedback*. And here is where the use of media as a recording device is most useful. For in its recorded form, instruction can be observed, reviewed, evaluated, altered, and improved.

After looking at this rather systematic approach to the design of instruction you might ask two questions:

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1) *how can your training efforts be helped most?* 2) *how can duplication be reduced?* Given a small staff and a limited budget, you might start using as much of your time and mental powers that can be devoted to this task and working out the objectives, approaching this task systematically without the use of media. If time and money permit, simple and inexpensive aids could be used for the development of instruction. David Curl, in a recent publication, lists some criteria for selecting presentation media such as 1) *how long will it be useful?* 2) *how many changes are anticipated?* 3) *what amount of training time is available?* 4) *how much space is available for any necessary hardware?* 5) *what is the skill background and literacy level of the trainees?* 6) *what is the probable cost?*

Dr. Cole has described the wide range of hardware available for use. The National Medical Audiovisual Center is a place one might reasonably turn to in seeking information on the performance of various types and brands of hardware in standing up under instructor or student use. Dr. Daniel presented a strong argument for the coordination of efforts by this group so that expensive production units duplicating each other will not be developed in various states, but rather be a coordinated effort done on a regional or a national level responsive to the needs of all of its members. Media people in the medical field met recently to discuss standardization of the media forms.

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Another group of medical media specialists will meet in the spring of 1970 to divide the work of developing materials, thereby avoiding costly duplication.

But before the work can be divided, a concensus on goals must be reached, and the surest way I know of accomplishing this agreement is to prepare a list of behavioral objectives so each participant can share a clear understanding of his part of the whole task.

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